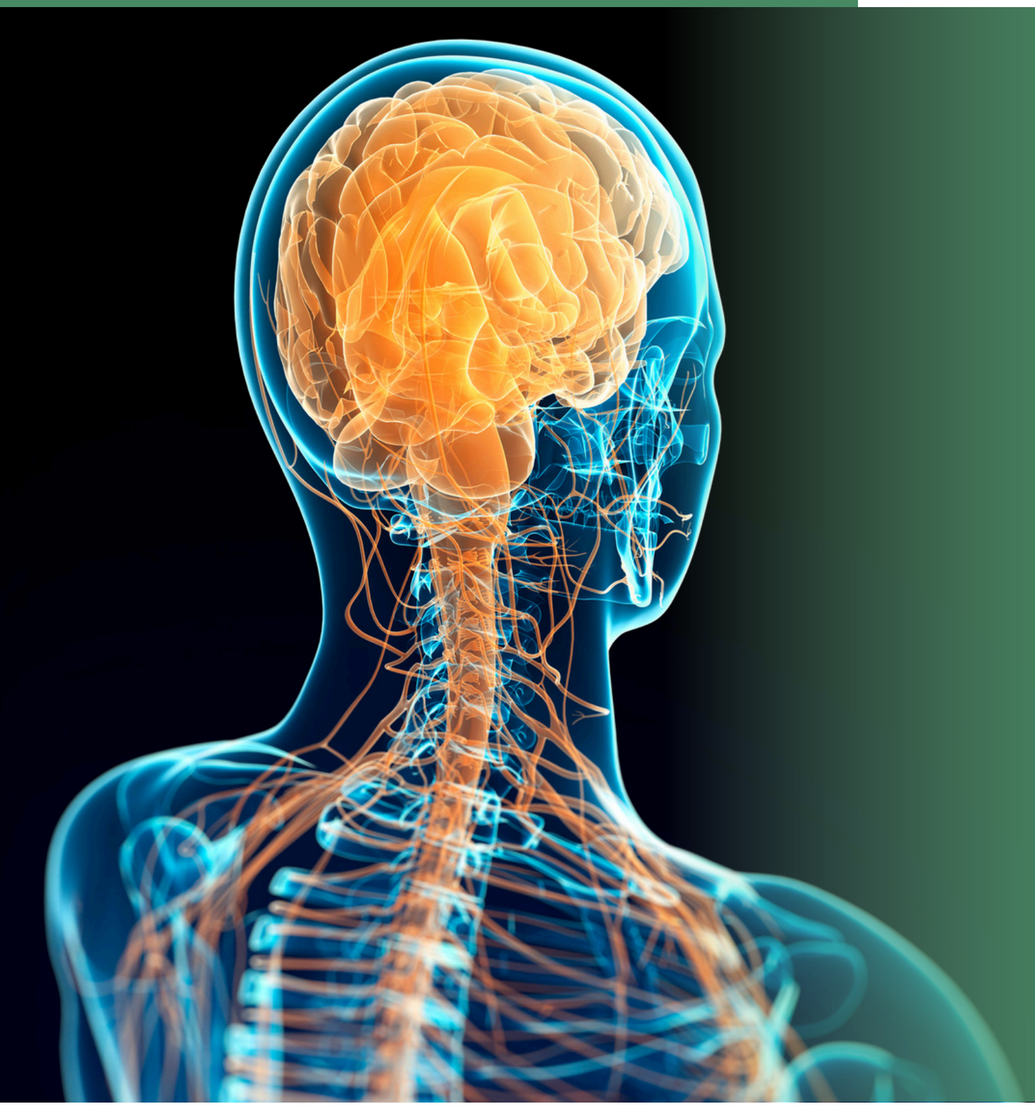
LECTURE #5 (20/10/2024)



STRUCTURE AND FUNCTION OF DIFFERENT PARTS OF BRAIN

BS MLT-II

H/DR. AYESHA RAUF

www.medmedals.com/bs-mlt-2

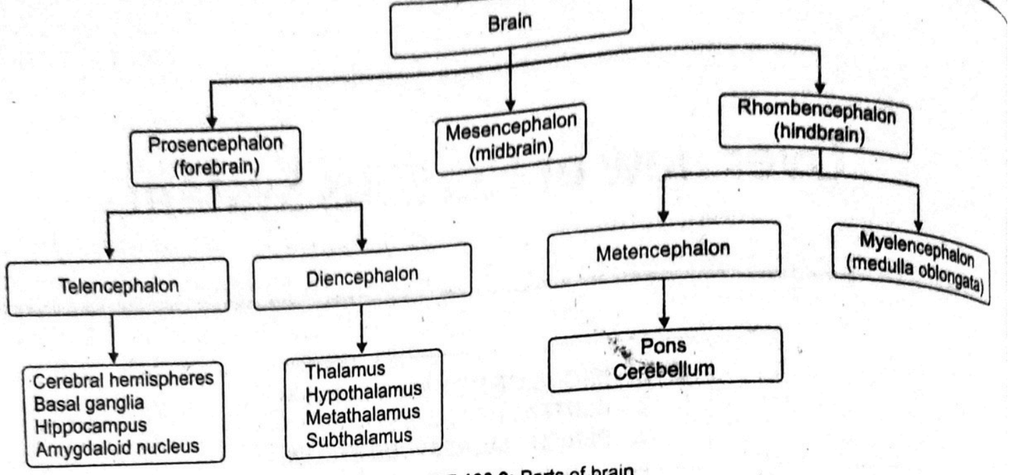


FIGURE 130.2: Parts of brain

Parts of Brain

Brain consists of three major divisions:

1. Prosencephalon.
2. Mesencephalon.
3. Rhombencephalon.

1. ***Prosencephalon***

Prosencephalon is otherwise known as **forebrain.** It is further divided into two parts:

i. Telencephalon, which includes cerebral hemispheres, basal ganglia, hippocampus and amygdaloid nucleus.
ii. Diencephalon, consisting of thalamus, hypothalamus, metathalamus and subthalamus.

2. ***Mesencephalon***

Mesencephalon is also known as **midbrain.**

3. ***Rhombencephalon***

Rhombencephalon or **hindbrain** is subdivided into two portions:

i. Metencephalon, formed by pons and cerebellum.
ii. Myelencephalon or medulla oblongata (Fig. 130.2).

Midbrain, pons and medulla oblongata are together called the brainstem.

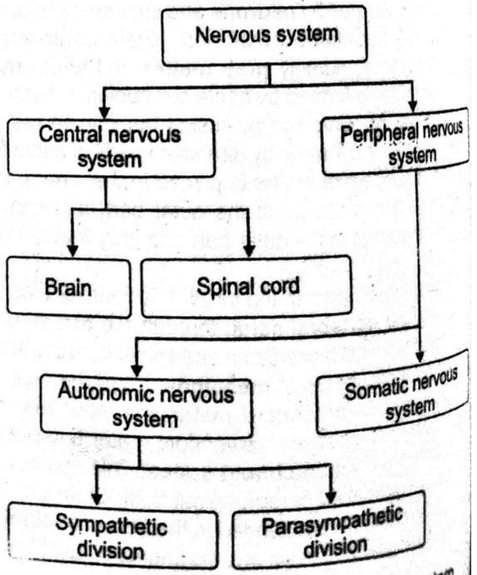
■ PERIPHERAL NERVOUS SYSTEM

Peripheral nervous system (PNS) is formed by neurons and their processes present in all regions of the body. It consists of cranial nerves, arising from brain and spinal nerves, arising from the spinal cord. It is again divided into two subdivisions:

1. Somatic nervous system.
2. Autonomic nervous system.

1. ***Somatic Nervous System***

Somatic nervous system is concerned with **somatic functions.** It includes the nerves supplying the skeletal muscles. Somatic nervous system is responsible for muscular activities and movements of the body (Fig. 130.3).



Parts of human brain

The human brain can be divided into three main parts:

1) Forebrain 2) Midbrain 3)Hind brain

1) Fore brain:

The Fore brain is the anterior part of the brain that can be divided into three functional parts:

i) Cerebrum ii) Thalamus iii) The limbic system

i) Cerebrum:

Cerebrum is the largest part of the brain.

Functions:

Cerebrum receives signals from many receptors, such as eyes, ears, touch receptors and convert them into their related responses. Cerebrum is also involved in speech, muscular voluntary movements, intelligence, thinking (reasoning), learning, judgment and memory.

ii) Thalamus:

Function: It serves as a relay station because it receives nearly all the impulses arriving from different sensory areas, e.g: from photoreceptors, Mechanoreceptors, from skin, etc and pass it to the cerebrum and limbic system.

■ PARTS OF CEREBELLUM

Cerebellum consists of a narrow, worm-like central body called **vermis** and two lateral lobes, the right and left **cerebellar hemispheres** (Fig. 147.1).

■ VERMIS

Vermis of cerebellum is formed by nine parts. Part of vermis on the upper surface of cerebellum is known as **superior vermis** and the part on lower surface of cerebellum is called **inferior vermis.**

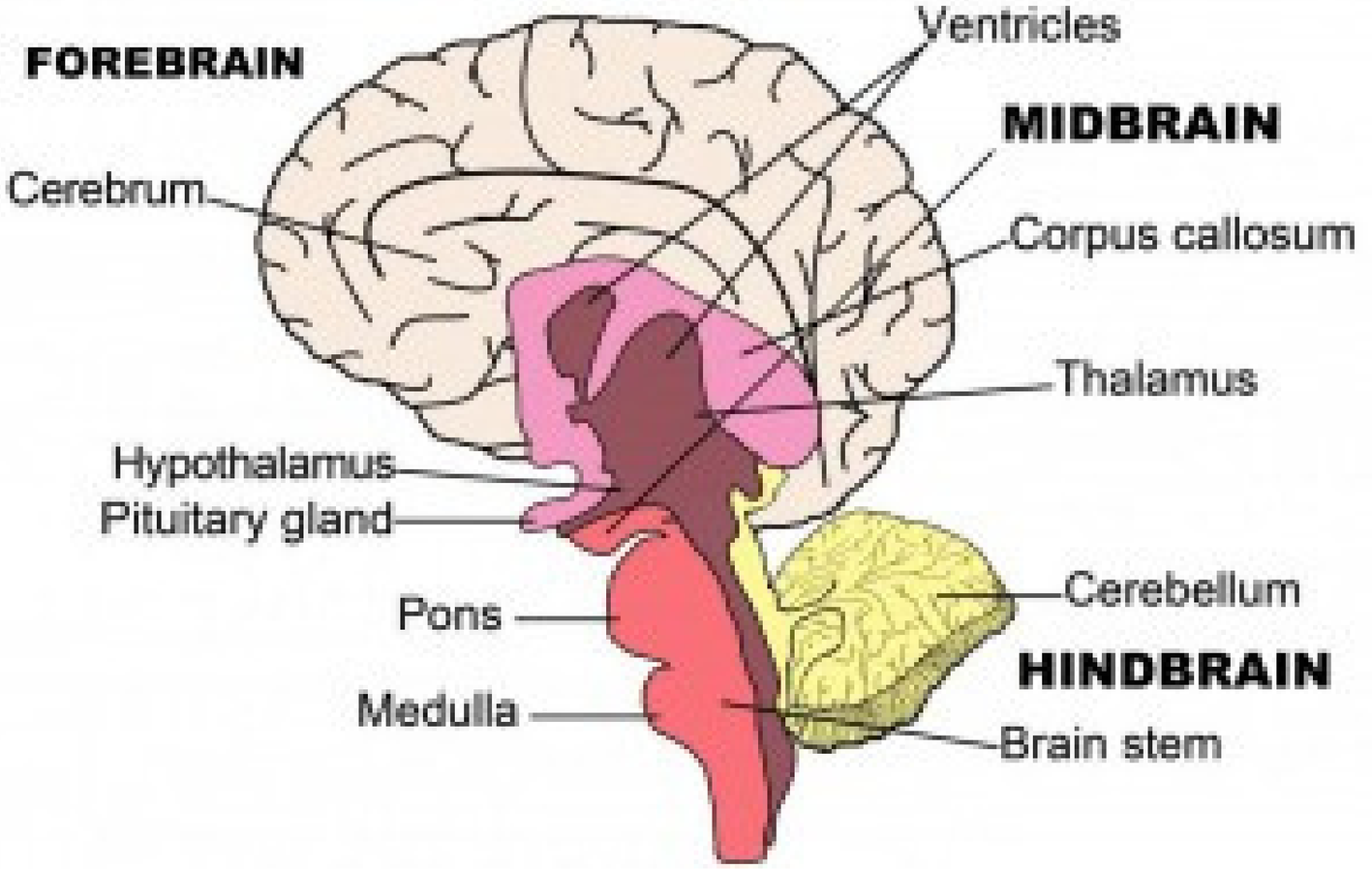
■ FUNCTIONAL ANATOMY OF CEREBELLUM

Cerebellum is made up of outer gray matter or **cerebellar cortex** and an inner **white matter**. White matter is formed by afferent and efferent nerve fibers of cerebellum. Gray masses called **cerebellar nuclei** are located within the white matter.

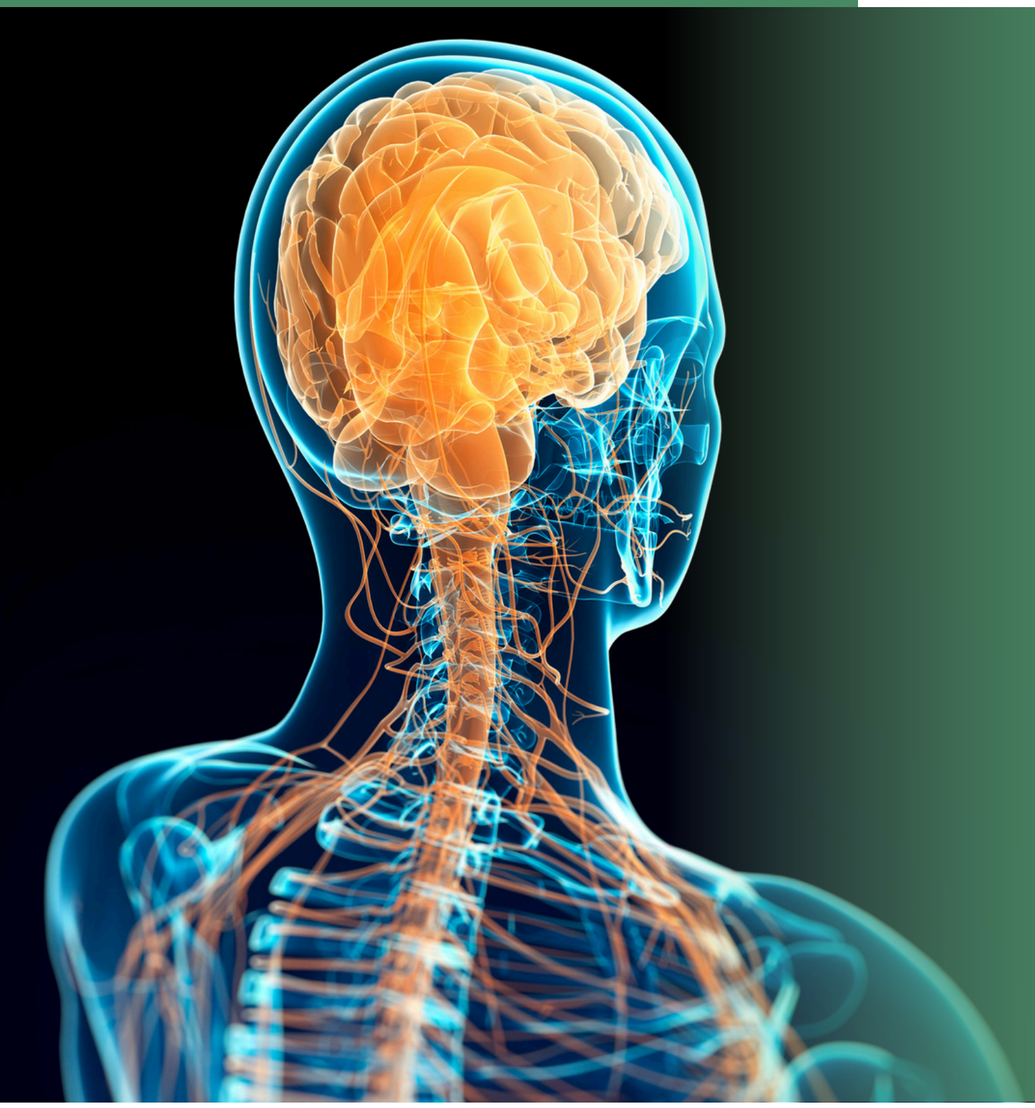
Cerebrum

The **cerebrum** is the largest part of the brain and consists of two **cerebral hemispheres** connected by a mass of white matter called the **corpus callosum** (Fig. 11.13). Each hemisphere extends from the frontal to the occipital bones; above the anterior and middle cranial fossae; and, posteriorly, above the tentorium cerebelli. The hemispheres are separated by a deep cleft, the **longitudinal fissure,** into which projects the **falx cerebri** (Fig. 11.13).

The surface layer of each hemisphere is called the **cortex** and is composed of **gray matter** (Fig. 11.2). The cerebral



LECTURE # 6(23/10/2024)



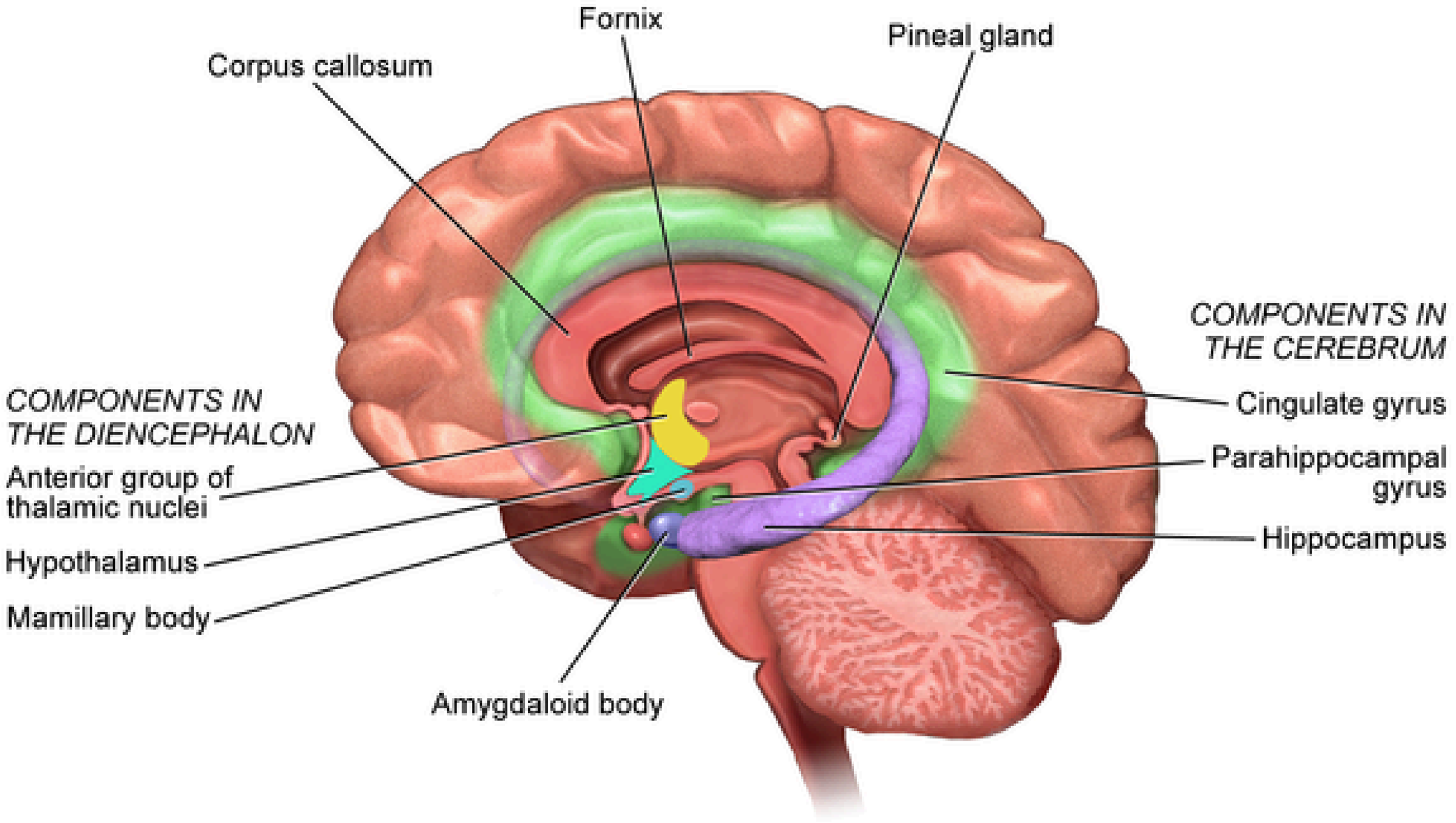
STRUCTURE AND FUNCTION OF DIFFERENT PARTS OF BRAIN

BS MLT-II

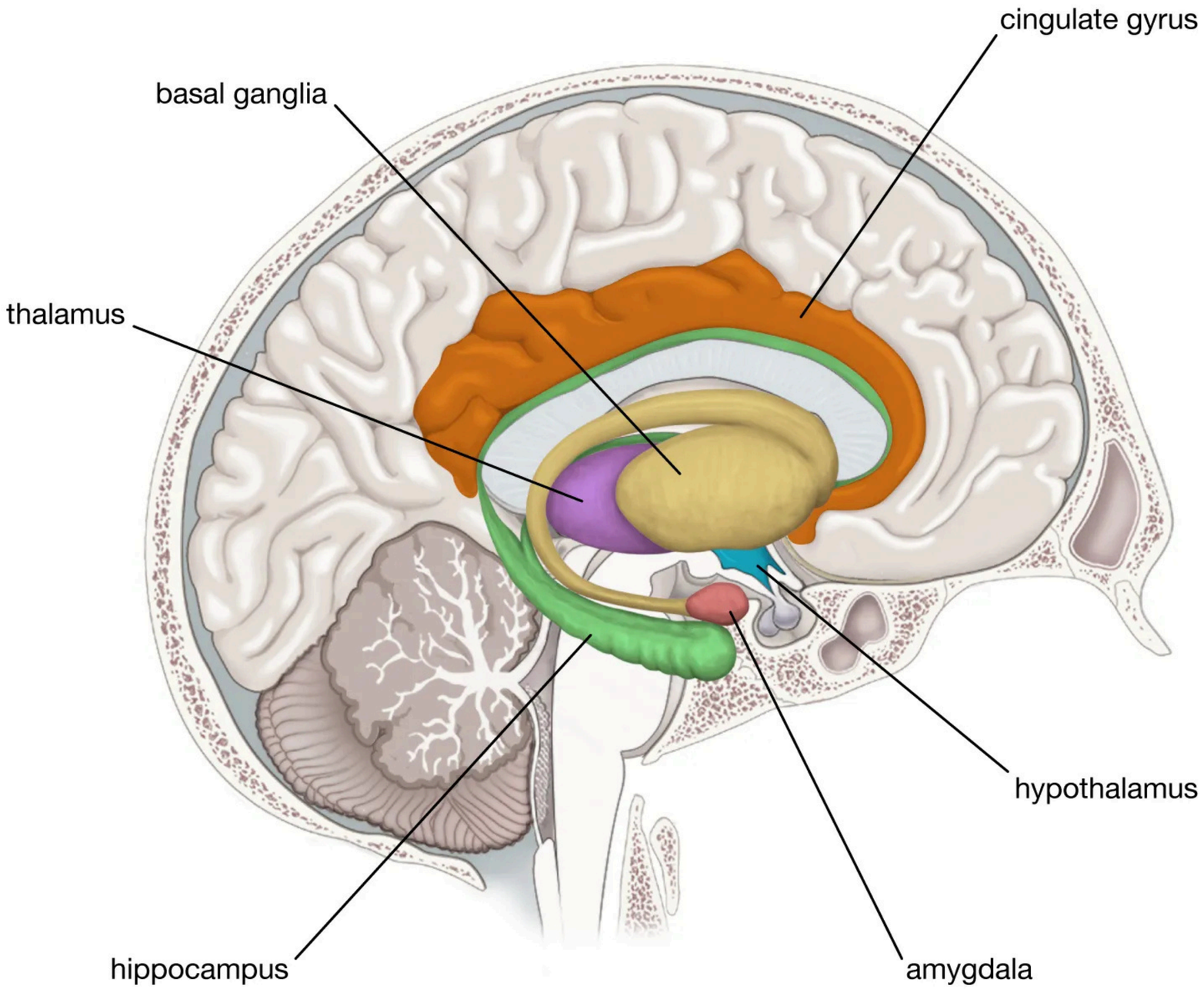
H/DR. AYESHA RAUF

www.medmedals.com/bs-mlt-2

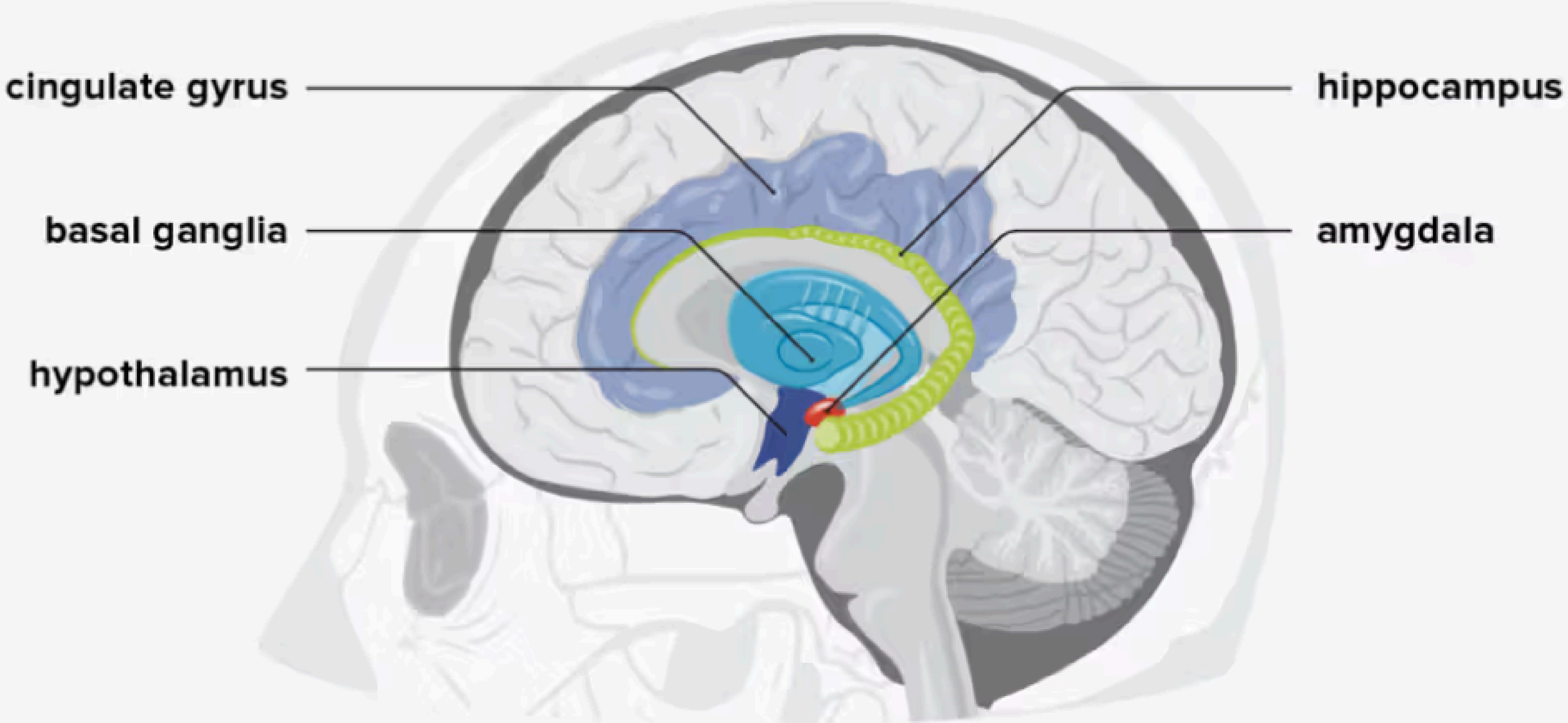
The Limbic System



Primary components of the limbic system



The limbic system



Functions of the limbic system

The limbic system helps regulate:

- emotional processing
- social processing
- learning
- motivation
- spatial memory

Hippocampus

The hippocampus consists of two structures on each side of the brain that serve as memory centers. These structures consolidate informationTrusted Source, which goes to parts of the cerebral cortex for storage.

The hippocampus forms short-term, long-term, and spatial memory, helping people to navigate their environment. It is also involved in the learning process.

Cingulate gyrus

The cingulate gyrus also helps with emotions, memory, and learning. It specifically linksTrusted Source outcomes with behavior, allowing people to see the cause and effect of their actions. As a result, the area may also play a role in the ability to predict adverse outcomes or sensations, enabling people to avoid them.

The cingulate gyrus may control autonomic motor functions, which are involuntary movements, such as those involved in digestion and breathing.

Amygdala

The amygdala lies next to the hippocampus. It is responsible for processing emotions, such as:

anger

happiness

anxiety

fear

The amygdala also helps with interpreting experiences and creating memories by attaching emotions to them. Other functions include learning to avoid fearful stimuli and contributing to the fight-or-flight response.

The amygdala also has has links with the olfactory system, or a person's sense of smell. It processes information about smells and tastes.

Hypothalamus

The hypothalamus helps to maintain homeostasis, or a steady internal state. It controls:

- blood pressure
- heart rate
- body temperature
- sexual activity
- thirst
- hunger

The hypothalamus maintains homeostasis by taking information from different parts of the brain, as well as responding to stimuli such as odor, light, and stress.

The hypothalamus also connects to regions of the brain involved in decision-making, creating an "interface" between the emotional parts and the thinking or cognitive parts of the brain.

Basal ganglia

The primary function of the basal ganglia is to regulate involuntary movements, including balance control and eye movements.

The parts of the basal ganglia that lie in the limbic region contribute to emotional behaviors and thinking. They also influence the brain’s reward system and help with reinforcement, which can play a role in habit formation.

iii) **The limbic system:**

The limbic system consists of three parts:

a) Hypothalamus b) Amygdala c) Hippocampus

a) **Hypothalamus:**

Functions:

Hypothalamus controls "Pituitary gland" that lie below it and attached to it, so the hypothalamus, with the help of pituitary gland, controls the body metabolism, body temperature, hunger, thirst (water balance), sleep, menstrual cycle, etc.

b) **Amygdala:** **Functions:** It controls the sensation of pleasure, sexual responses, fear, anger, etc.

c) **Hippocampus:**

It deals with the formation of long-term memories, so important for learning.

2) **Mid brain:**

The mid brain is a reduce part of brain in human. It lies below the lower part of the cerebrum, in the mid part of the two cerebral hemispheres.

Function: Mid brain contains a network formation that connect hindbrain and fore brain.

3) **Hind brain :**

The hind brain consists of three parts:

a) Pons b) Medulla oblongata c) Cerebellum

a) **Pons:**

Functions:

It influences the rate of breathing, transition between sleep and wakefulness, and also different stages of sleep. It also acts as a bridge to transmit impulses between cerebrum, cerebellum and medulla.

b) **Medulla oblongata:**

Functions: It controls several **involuntary functions** such as breathing, heart rate, blood pressure, coughing and peristalsis.

The **limbic system** is a group of interconnected brain structures that help regulate your emotions and behavior. The structures (also known as components or parts) of the limbic system work together with other brain regions by processing your memory, thoughts and motivations, then tell your body how to respond

Functions and placements of 12 cranial nerves:

There are total 12 pairs of cranial nerves that originate from our brain and brain stem. Each of them carries different functions related to different senses of body.

1. **Olfactory Nerve:** This is a type of sensory nerve that contributes in the sense of smell in human being.

2. **Optic nerve** :This again is a type of sensory nerve that transforms information about vision to the brain. To be specific this supplies information to the retina in the form of ganglion cells.

3. **Oculomoter nerve:** This is a form of motor nerve that supplies to different centers along midbrain. Its functions include superiorly uplifting eyelid, superiorly rotating eyeball and construction of pupil .

4. **Trochlear Nerve:** This motor nerve also supplies to the midbrain and performs the function of handling the eye muscles and turning the eye.

5. **Trigeminal Nerve:** This is a type of largest cranial nerve in all and performs many sensory functions related to nose, eyes, tongue and teeth.

6. **Abducent Nerve** : This is again a type of motor nerve that supplies to the pons and perform function of turning eye laterally.

7. **Facial Nerve** : This motor nerve is responsible for different types of facial expressions. This also performs some functions of sensory nerve by supplying information about touch on face and senses of tongue in mouth. It is basically present over brain stem.

8. **Vestibulocchlear Nerve:** This motor nerve is basically functional in providing information related to balance of head and sense of sound or hearing. I

9. **Glossopharyngeal Nerve:**
This is a sensory nerve which carries sensory information from pharynx (initial portion of throat) and some portion of tongue and palate. The information sent is about temperature, pressure and other related facts.
.The nerve also carries some motor functions such as helping in swallowing food.

10. **Vagus Nerve:**
This is also a type of mixed nerve that carries both motor and sensory functions. This basically deals with the area of pharynx, larynx, esophagus, trachea, bronchi,

some portion of heart and palate. It works by constricting muscles of the above areas. In sensory part, it contributes in the tasting ability of the human being.

11. **Spinal accessory nerve**

As the name indicate this motor nerve supplies information about spinal cord, and other surrounding muscles. It also provides muscle movement of the shoulders and surrounding neck.

12. **Hypoglossal nerve**

This is a typical motor nerve that deals with the muscles of tongue.

Types Of cranial nerves

Some Say Money Matter But My Brother Says Big Brains Matter More

olfactory - Some

optic - Say

oculomotor - Money

trochlear - Matter

trigeminal - But

abducens - My

facial - Brother

vestibulocochlear - Says

glossopharyngeal - Big

vagus - Brains

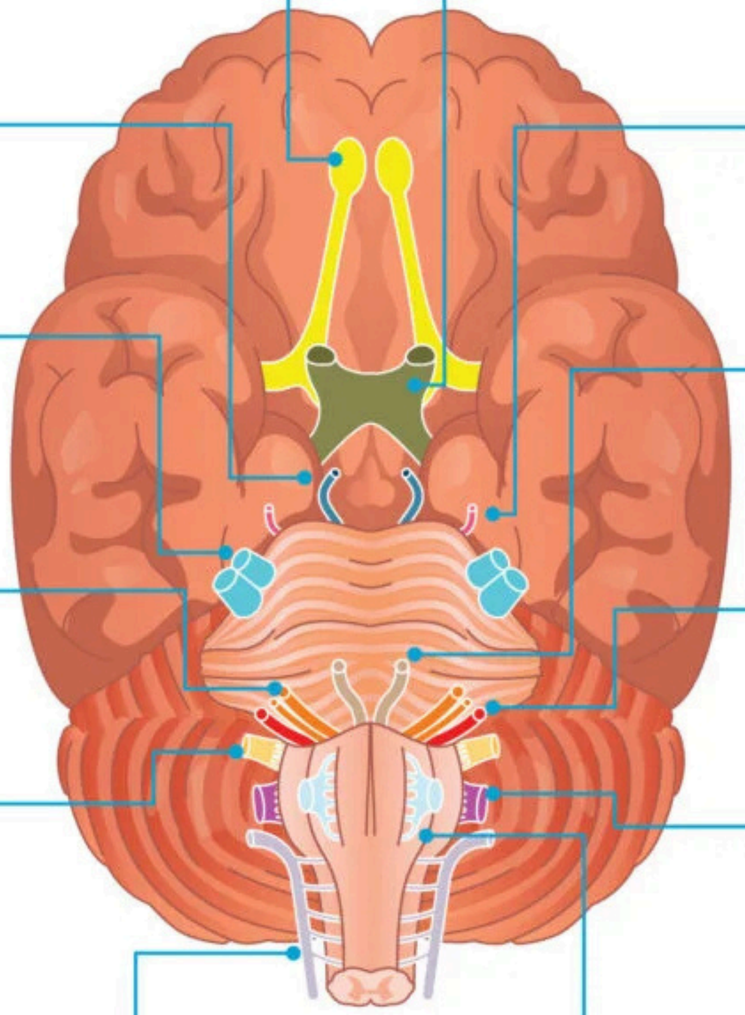
accessory - Matter

hypoglossal - More

S - Sensory
M - Motor
B - Both

Cranial Nerve	Mnemonic	Function	Origin
I – Olfactory Nerve	Oh	Special Sensory	Cerebrum
II – Optic Nerve	Oh	Special Sensory	Cerebrum
III – Oculomotor Nerve	Oh	Motor	Midbrain
IV – Trochlear Nerve	To	Motor	Midbrain
V – Trigeminal Nerve	Touch	Sensory and motor	Pons
VI – Abducens Nerve	And	Motor	Pons
VII – Facial Nerve	Feel	Sensory, special sensory and motor	Pons
VIII – Vestibulocochlear Nerve	Very	Special sensory	Pons
IX – Glossopharyngeal Nerve	Good	Sensory, special sensory, autonomic, and motor	Medulla
X – Vagus Nerve	Velvet	Sensory, motor, autonomic	Medulla
XI - Accessory Nerve	Ah	Motor	Medulla
XII – Hypoglossal Nerve	Heaven	Motor	Medulla

12 Cranial Nerves



olfactory
smell

optic
vision

oculomotor
eye movement and pupil reflex

trochlear
eye movement

trigeminal
face sensation and chewing

abducens
eye movement

facial
face movement and taste

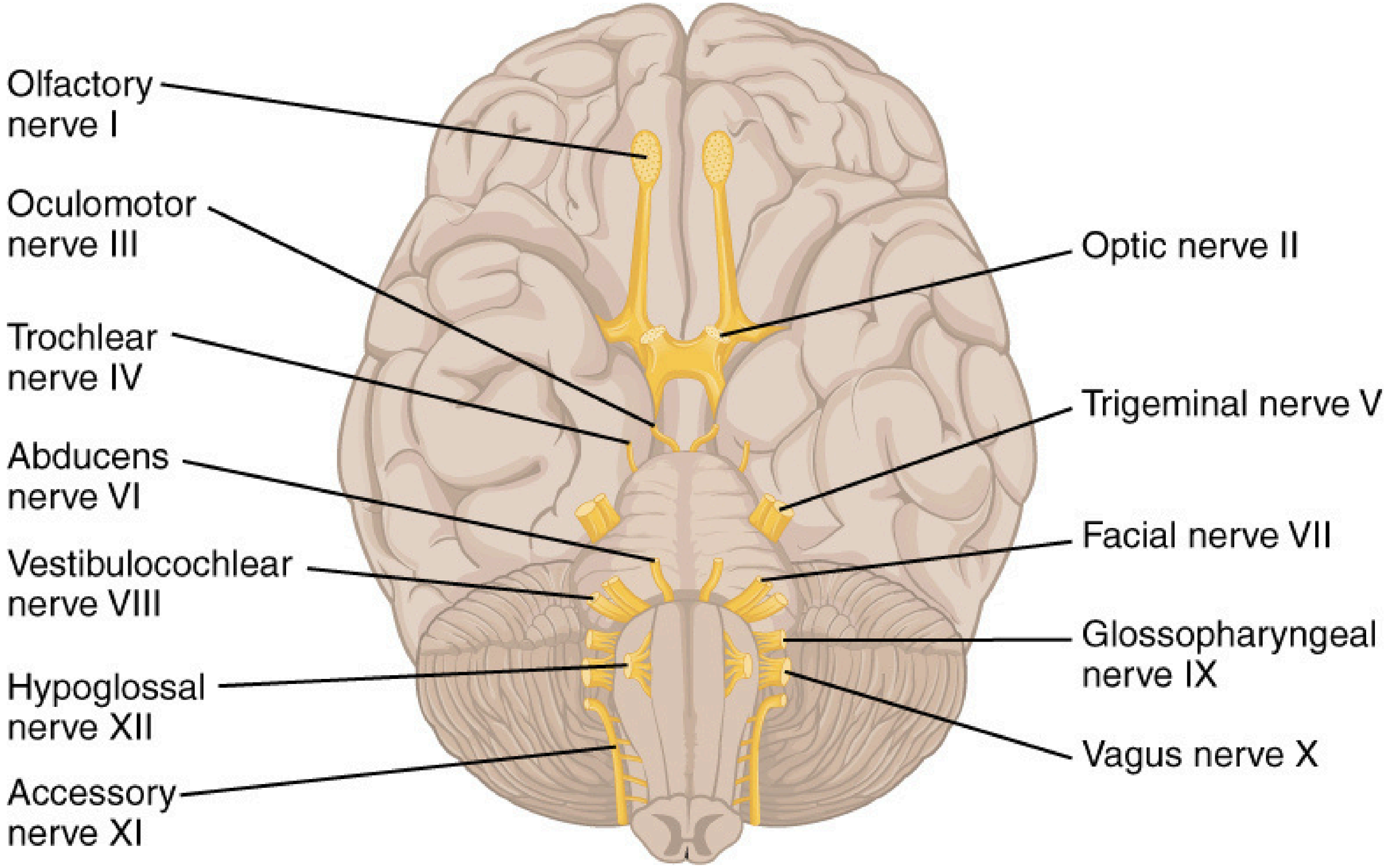
vestibulocochlear
hearing and balance

glossopharyngeal
throat sensation, taste, and swallowing

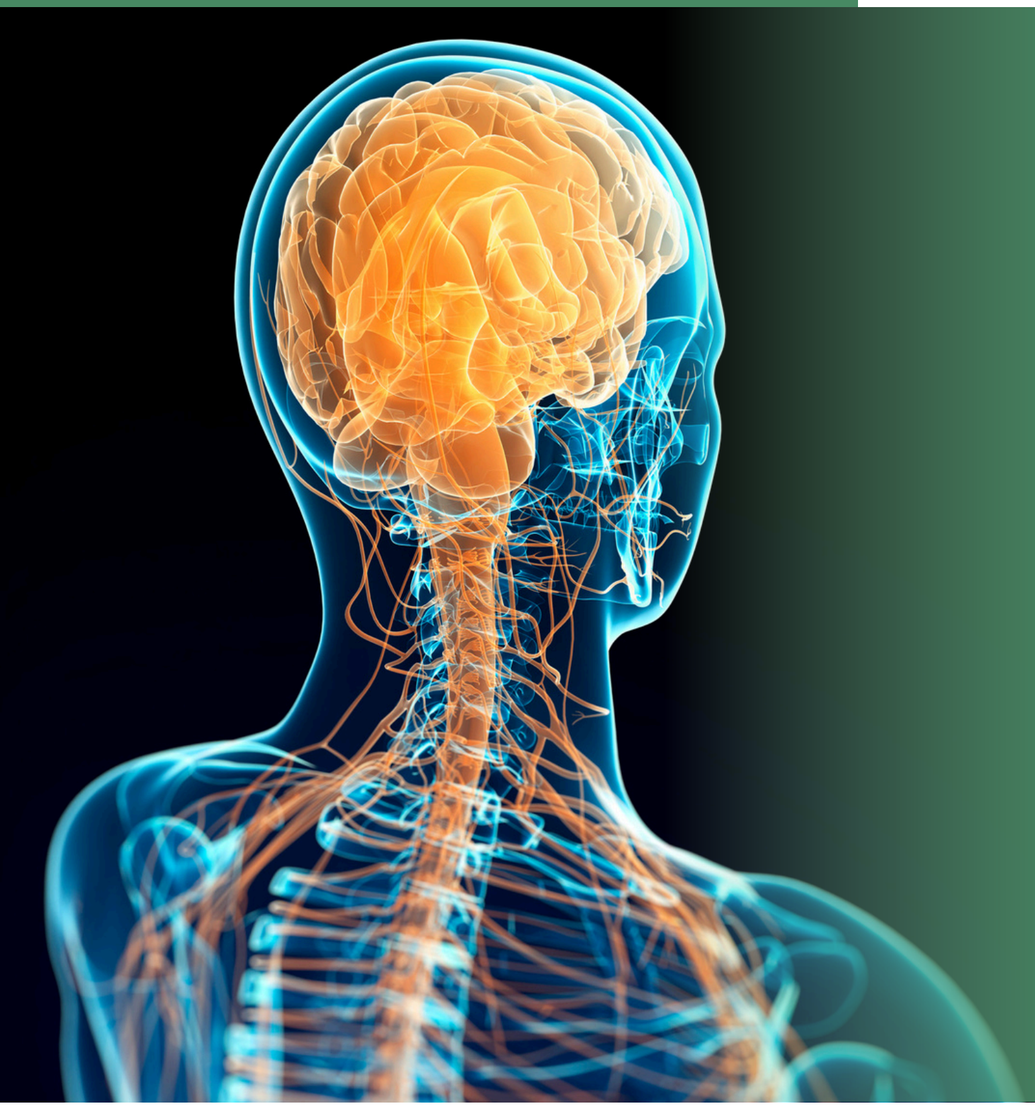
vagus
movement, sensation, and abdominal organs

accessory
neck movement

hypoglossal
tongue movement


Olfactory nerve I
Oculomotor nerve III
Trochlear nerve IV
Abducens nerve VI
Vestibulocochlear nerve VIII
Hypoglossal nerve XII
Accessory nerve XI
Optic nerve II
Trigeminal nerve V
Facial nerve VII
Glossopharyngeal nerve IX
Vagus nerve X

LECTURE # 6(23/10/2024)



SPINAL CORD

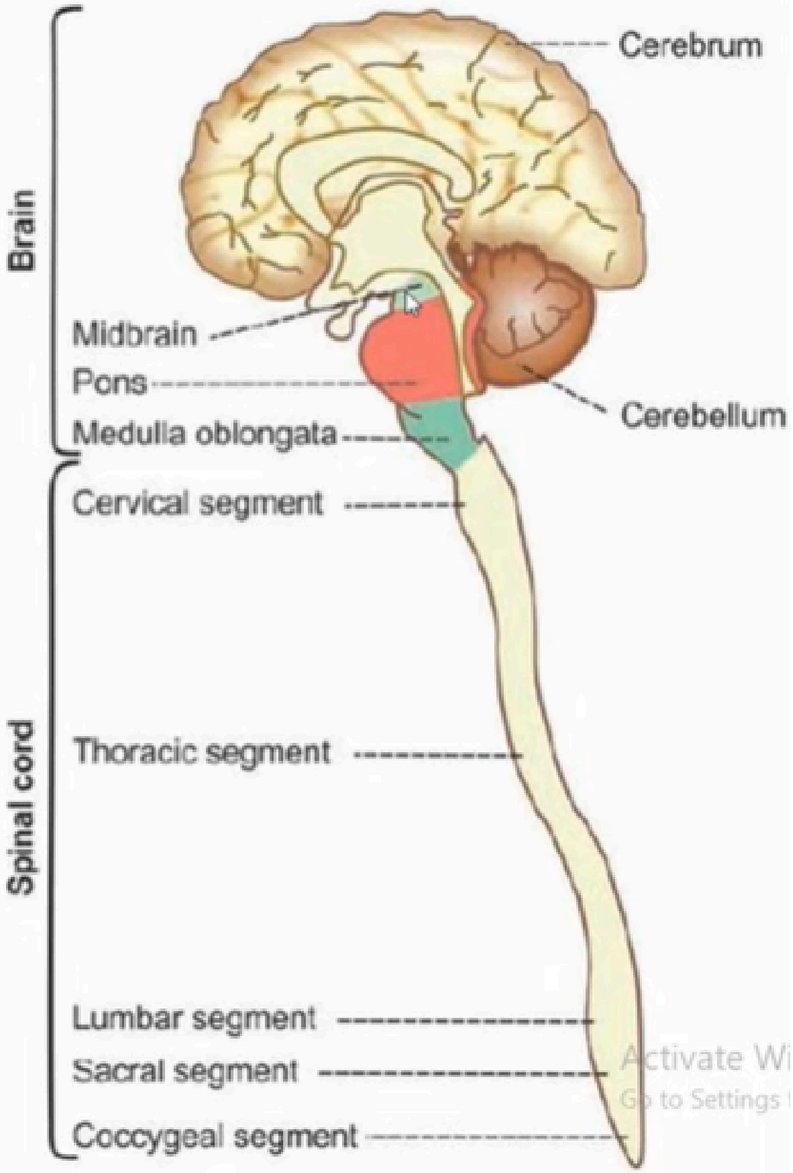
BS MLT-II

H/DR. AYESHA RAUF

www.medmedals.com/bs-mlt-2

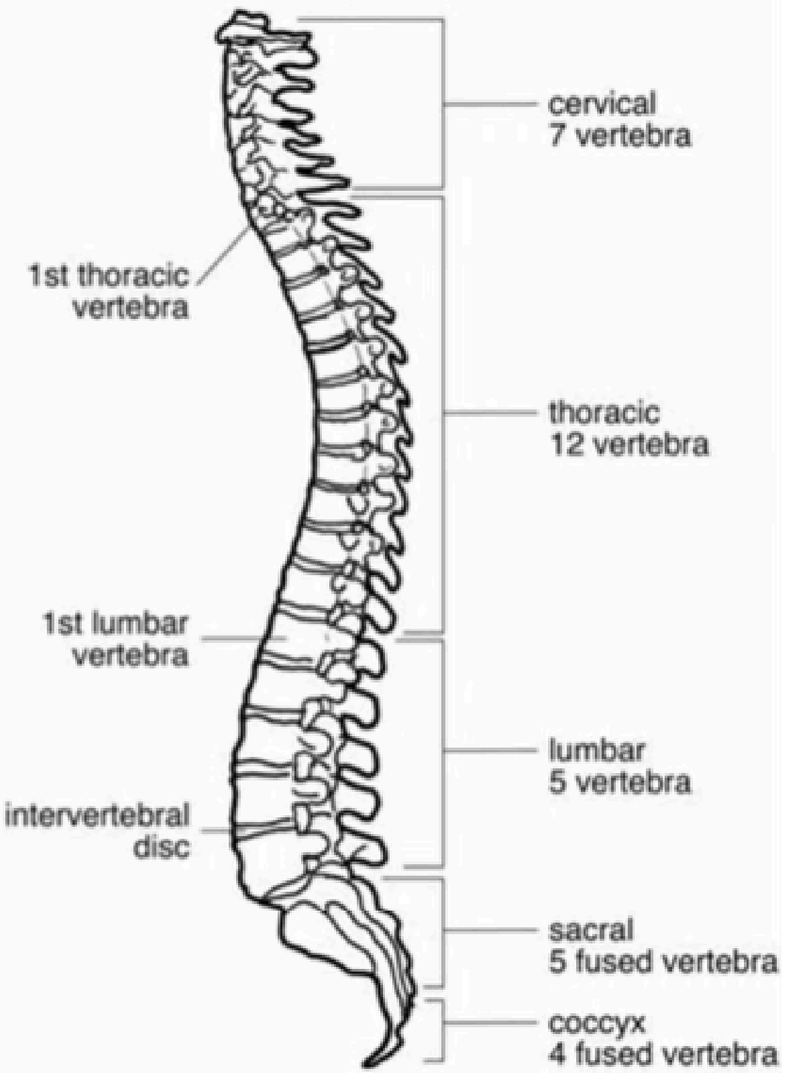
Spinal Cord

- Spinal cord is a long, thin, tube like structure which is the part of central nervous system.
- It starts from the medulla oblongata in the brain stem and extends down to between the 1st and 2nd lumbar vertebrae.
- Length:- **Men**- around 45 cm (18 in) and
  Female -around 43 cm (17 in).
- Spinal cord is a main pathway for information connecting the brain and the rest of body.



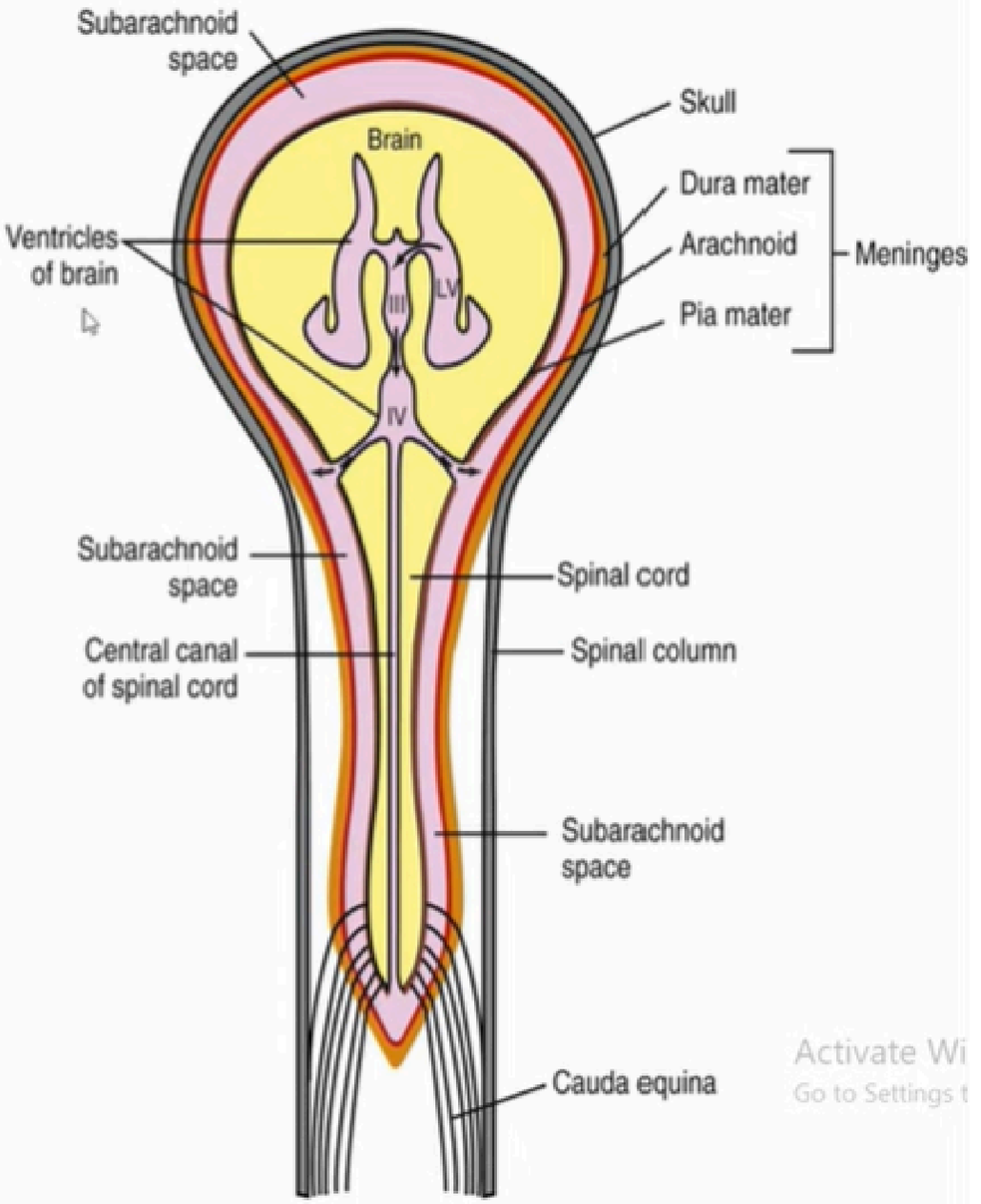
Vertebral column or spinal column

- A column of bones called vertebrae make up the spine (spinal column or vertebral column or back bone).
- Just as skull protects the brain, vertebrae protects the spinal cord.
- Between the vertebrae are discs made of cartilage(intervertebral disc), which act as cushions, and give some flexibility to spine.
- **Spine is made of 33 individual back bones (vertebrae).**
- **Cervical vertebrae – 7 (C1 to C7)**
- **Thoracic vertebrae – 12 (T1 to T12)**
- **Lumbar vertebrae – 5 (L1 to L5)**
- **Sacrum (Sacral vertebrae) - 5 (S1 to S5) (fused)**
- **Coccyx (Caudal vertebrae) tail bone - 4 (fused)**



coverings

- Like brain spinal cord is protected and nourished by three layers of membranes called **meninges.**
- Dura mater(outer)-b/w Dura mater and vertebrae is a space**(epidural space)**filled with adipose tissue and blood vessels. Dural sac ends at 2nd sacral vertebra.
- Arachnoid mater(middle)- space b/w arachnoid and underlying Pia matter is **subarachnoid space** which contain CSF(cerebrospinal fluid)
- Pia mater(inner)- tightly associated with spinal cord

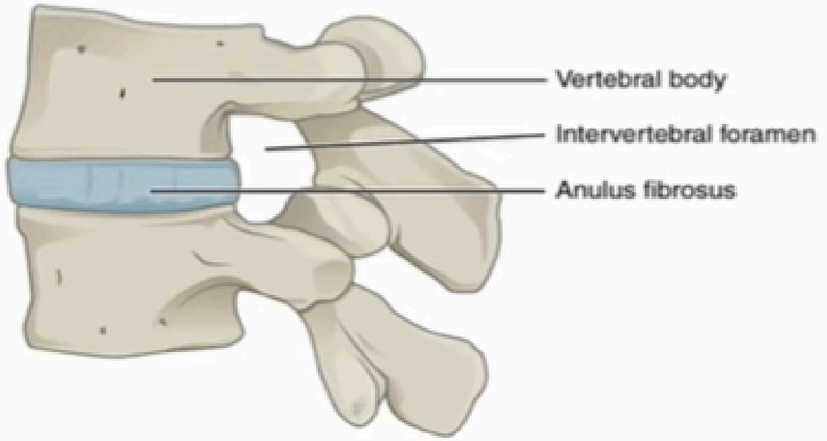


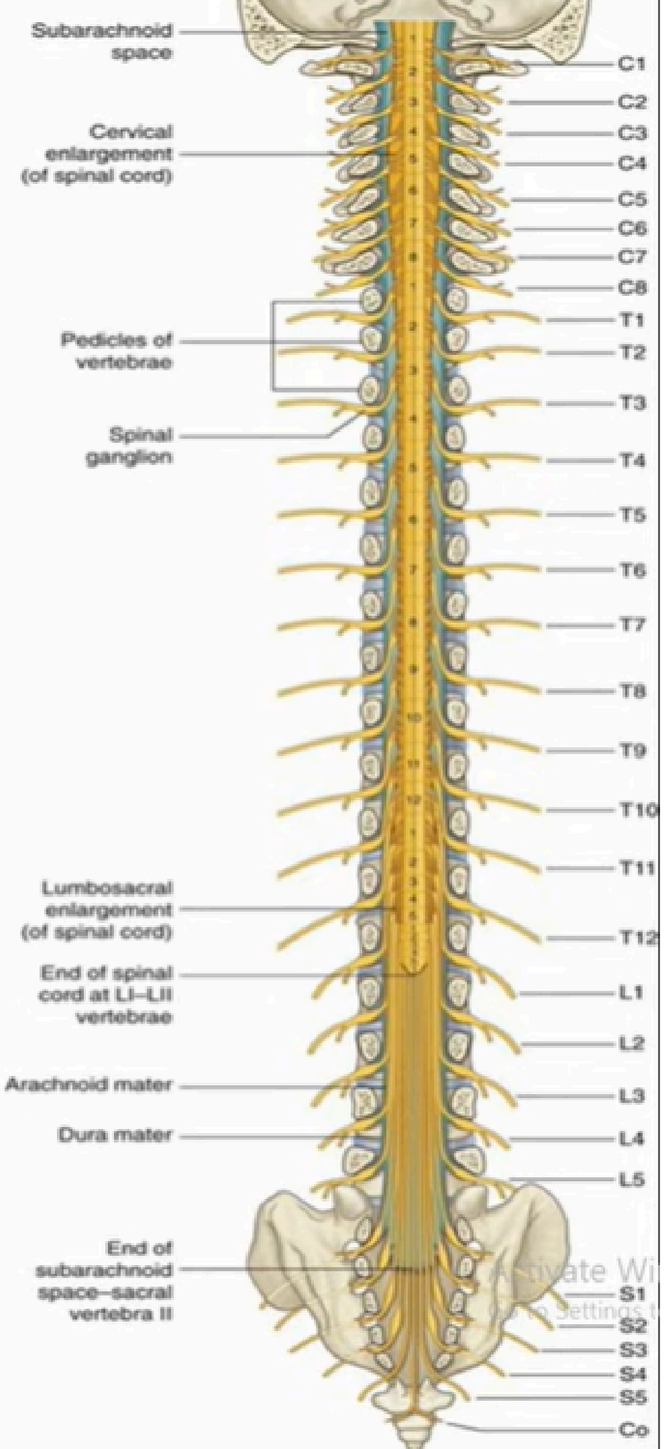
Spinal cord segments

- Spinal cord is divided into 31 segments, which is correspond 31 pairs of spinal nerves which arise from spinal cord.

1. Cervical segment/cervical spinal nerve = 8
2. Thoracic segment/ thoracic spinal nerve =12
3. Lumbar segment/ lumbar spinal nerves =5
4. Sacral segment/sacral spinal nerves =5
5. Coccygeal segment/ coccygeal nerves =1

Total =31

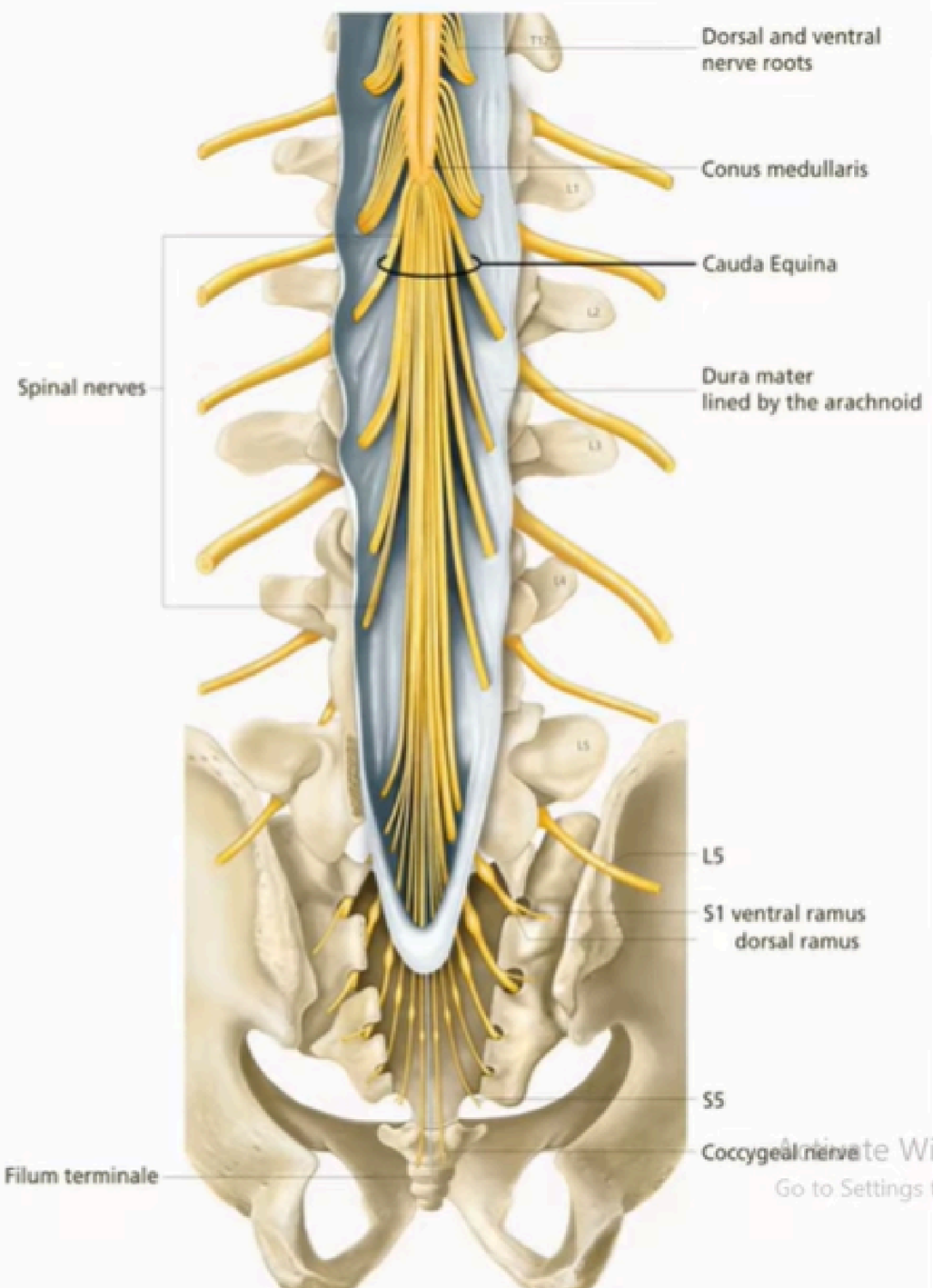




Structures

- Conus medullaris – spinal cord end around the L1/L2 vertebral level, forming a structure known as conus medullaris.
- Cauda equina- spinal cord ends at L1/L2 but a bundle of nerves extends beyond the cord up to L5 known as cauda equina. It carries nerve impulses to and from the legs.
- Filum terminale- an extension of Pia mater that extends from conus medullaris to the tail bone.

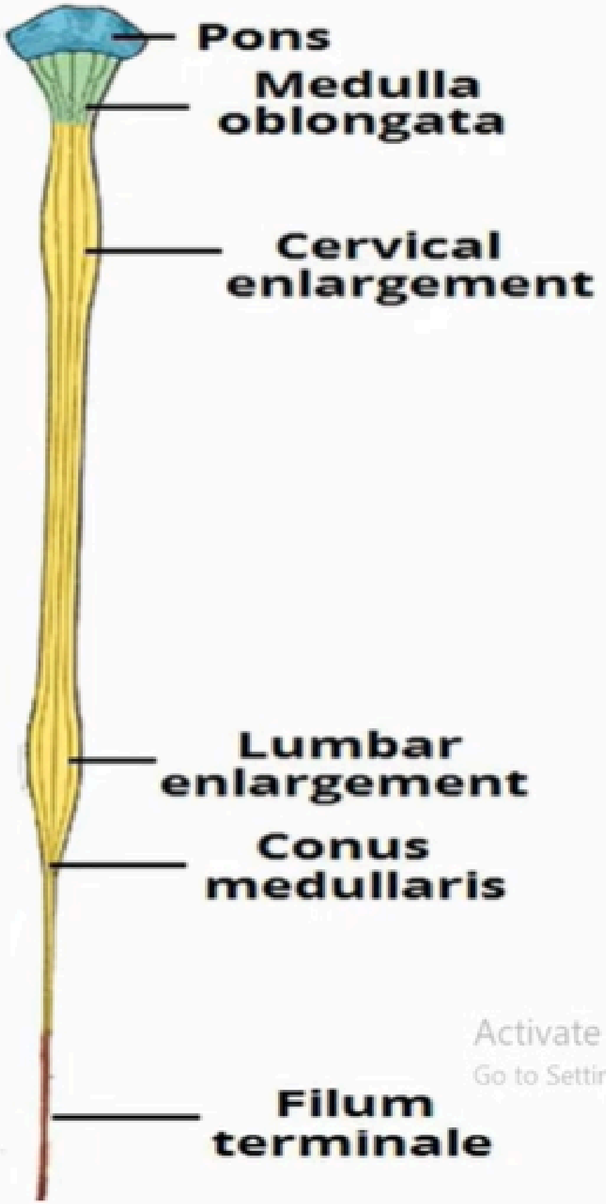
  Helps to anchor the spinal cord in place.



Enlargements

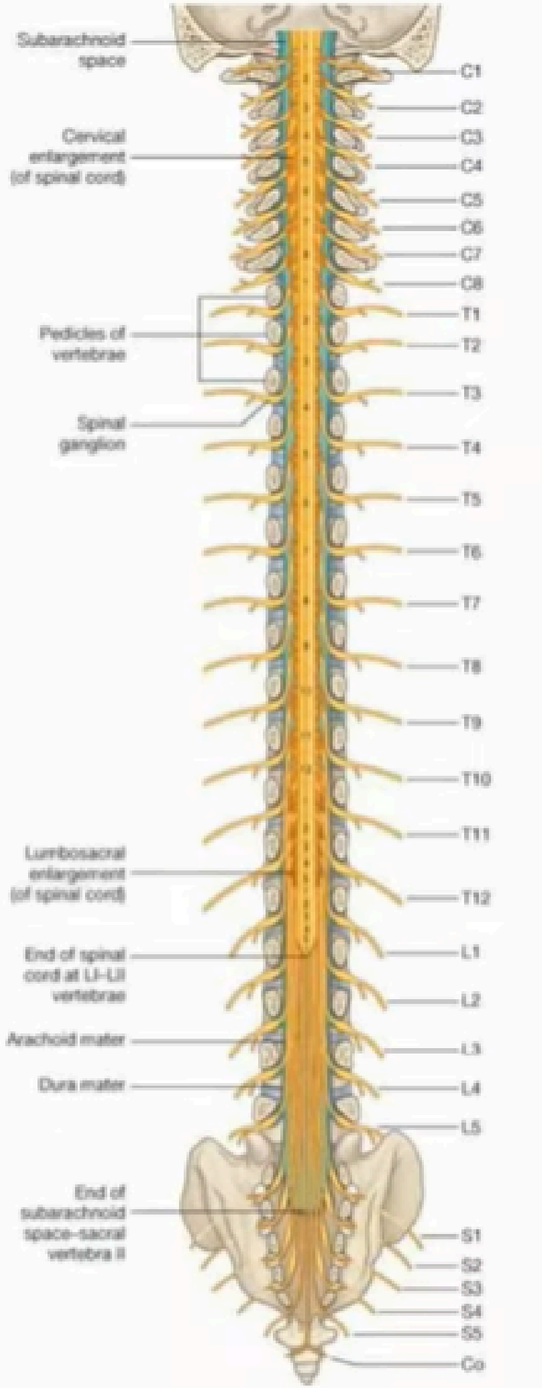
- Spinal cord has two swellings

1. Cervical enlargement-from spinal cord segment **C4-T1**(Vertebral level C4-T1).Corresponds to brachial plexus nerves which supply upper limb.
2. Lumbar enlargement- from spinal cord segment **L2-S3** (Vertebral level T9-T12). Corresponds to lumbosacral plexus which innervates lower limb.

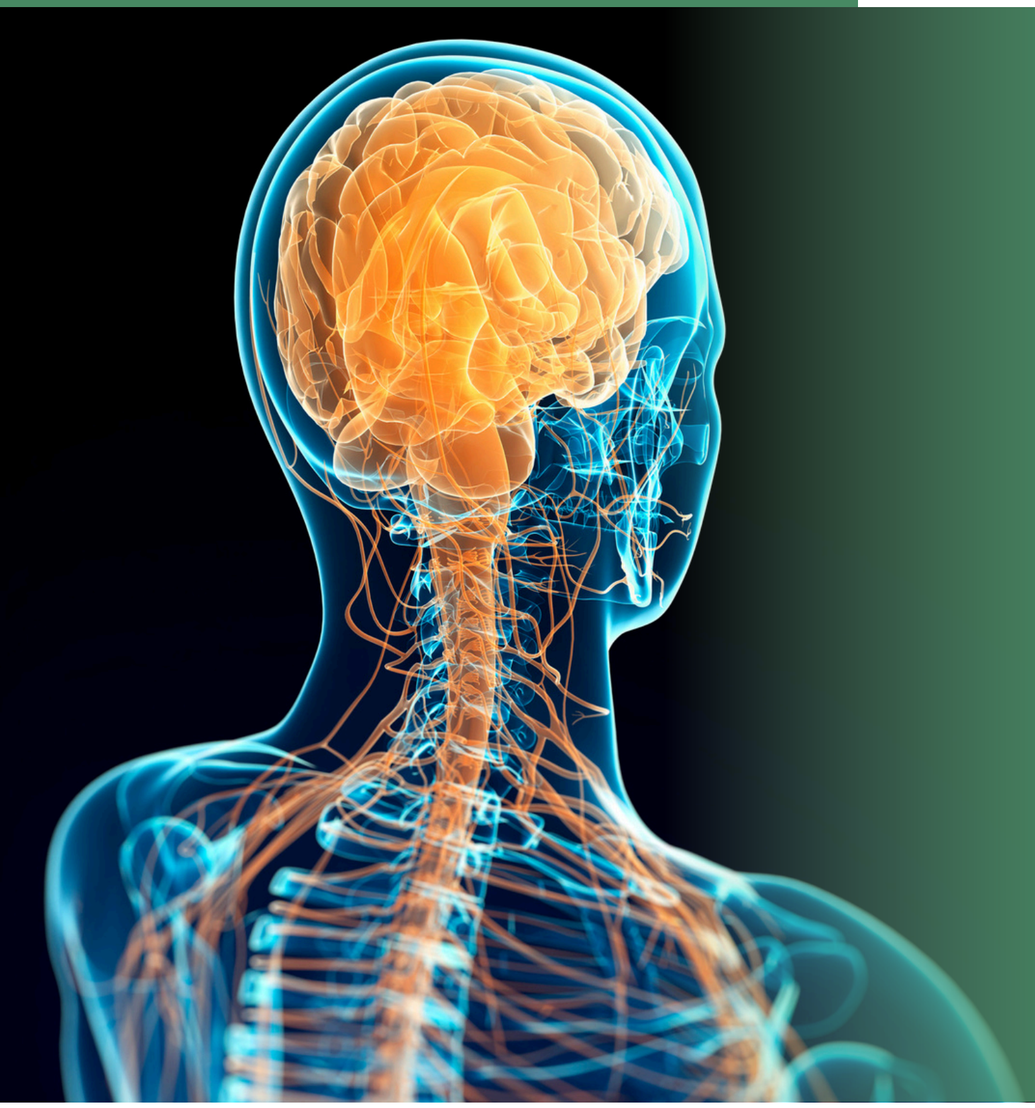


Lumbar puncture

- Lumbar puncture or spinal tap is a procedure in which a needle is inserted into the spinal canal below L2 Level (b/w L3-4 OR L4-5) in order not to injure the spinal cord.



LECTURE # 7(28/10/2024)



SPINAL CORD

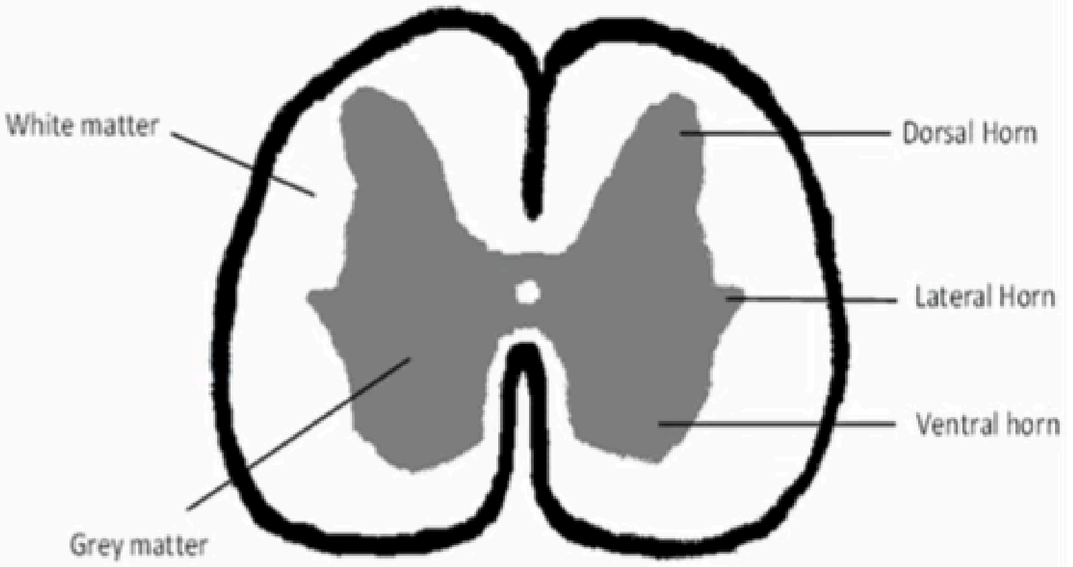
BS MLT-II

H/DR. AYESHA RAUF

www.medmedals.com/bs-mlt-2

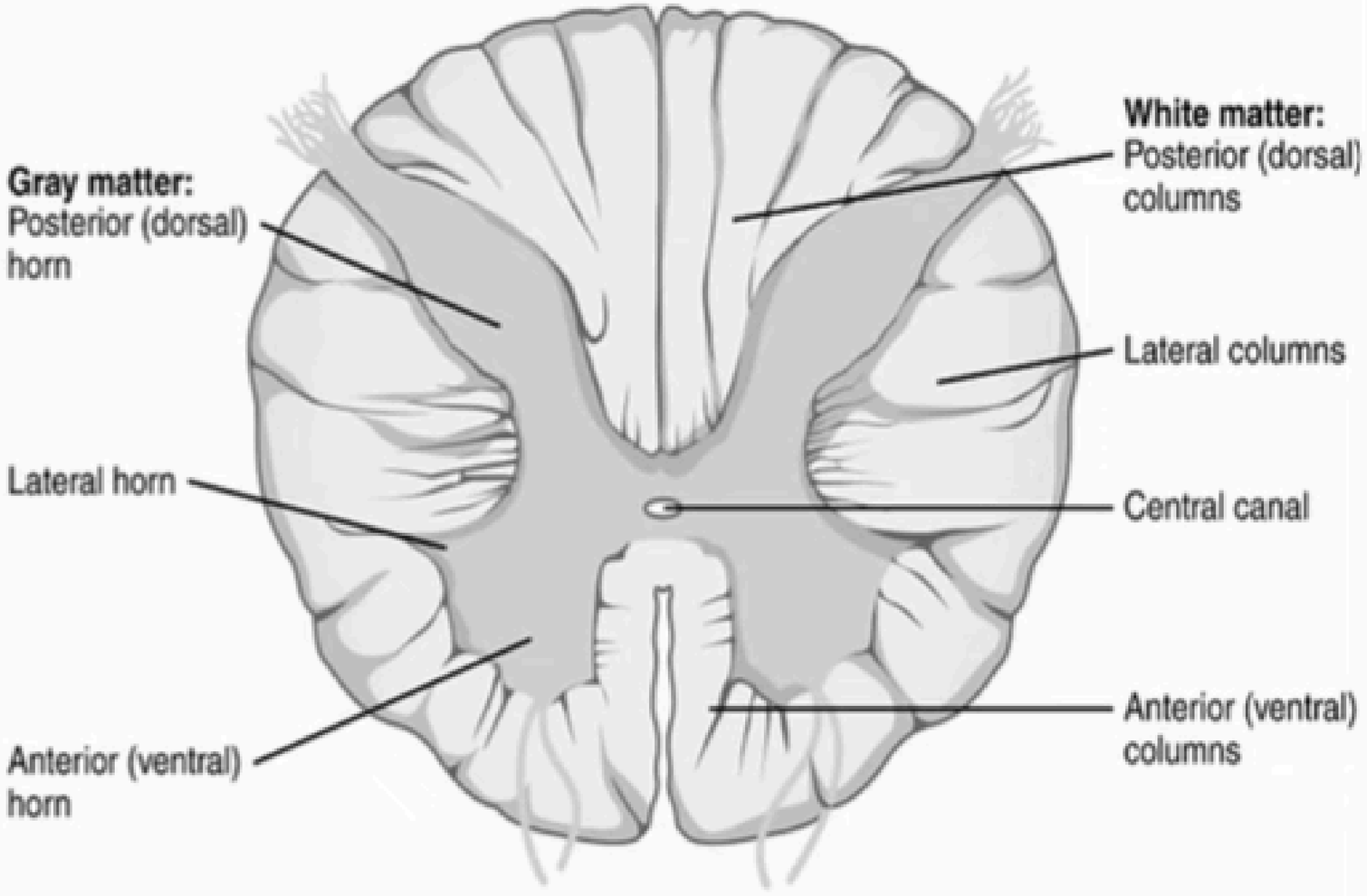
Grey matter of spinal cord

- Spinal cord is composed of an inner core of grey matter, surrounded by an outer covering of white matter.
- On cross section- arrangement of grey matter in spinal cord resembles the shape of butterfly.
- Grey matter consists of nerve cell bodies, dendrites.
- Horns/columns- **2 posterior/dorsal**
  2 lateral
  2 anterior/ventral
- Exactly in the center of grey matter, there is a canal called central canal, which is an extension from the fourth ventricle, containing cerebrospinal fluid.
- Part of grey matter anterior to central canal is anterior grey commissure
- Part of grey matter posterior to central canal is posterior grey commissure



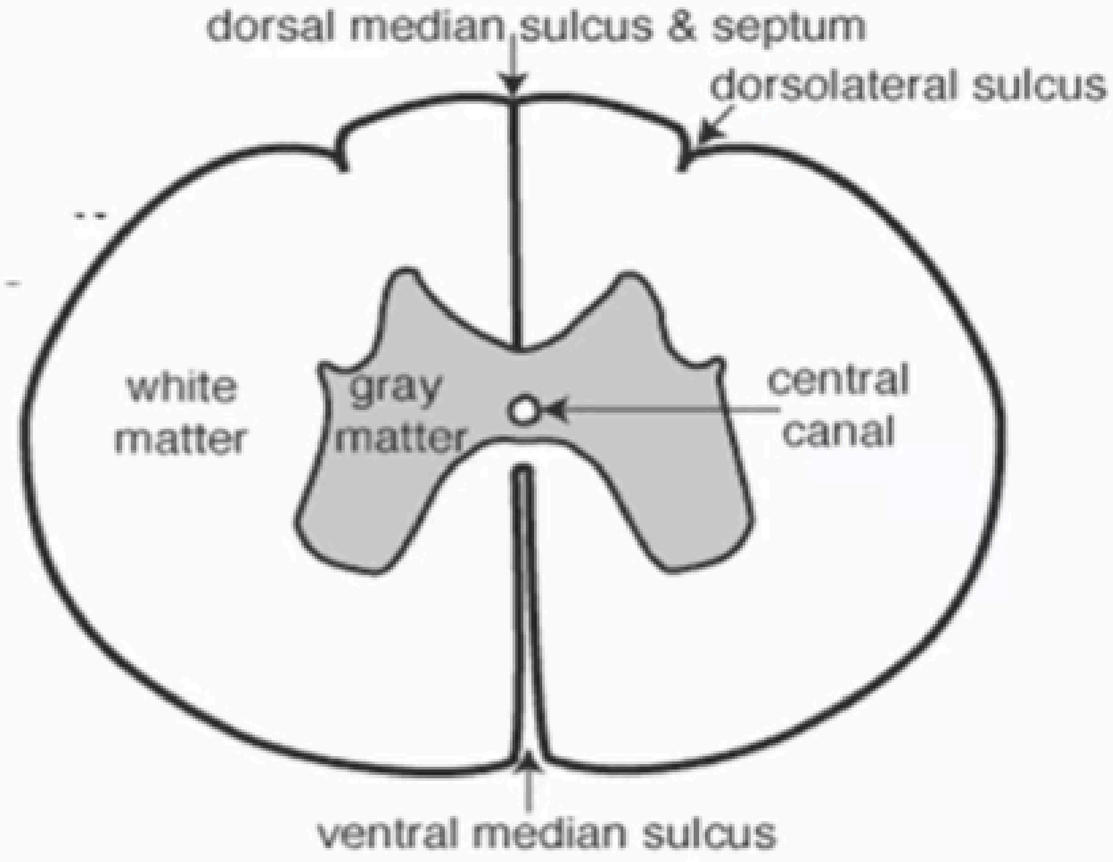
White matter

- White matter surrounds grey matter in spinal cord.
- White matter consists of is divided into **three columns/ tracts/ funiculi** - anterior, lateral and posterior.
- These tracts are formed by sensory nerve fibres ascending to the brain and motor nerve fibres descending from the brain.
- Anterior to central canal is anterior white commissure
- Posterior to central canal is posterior white commissure



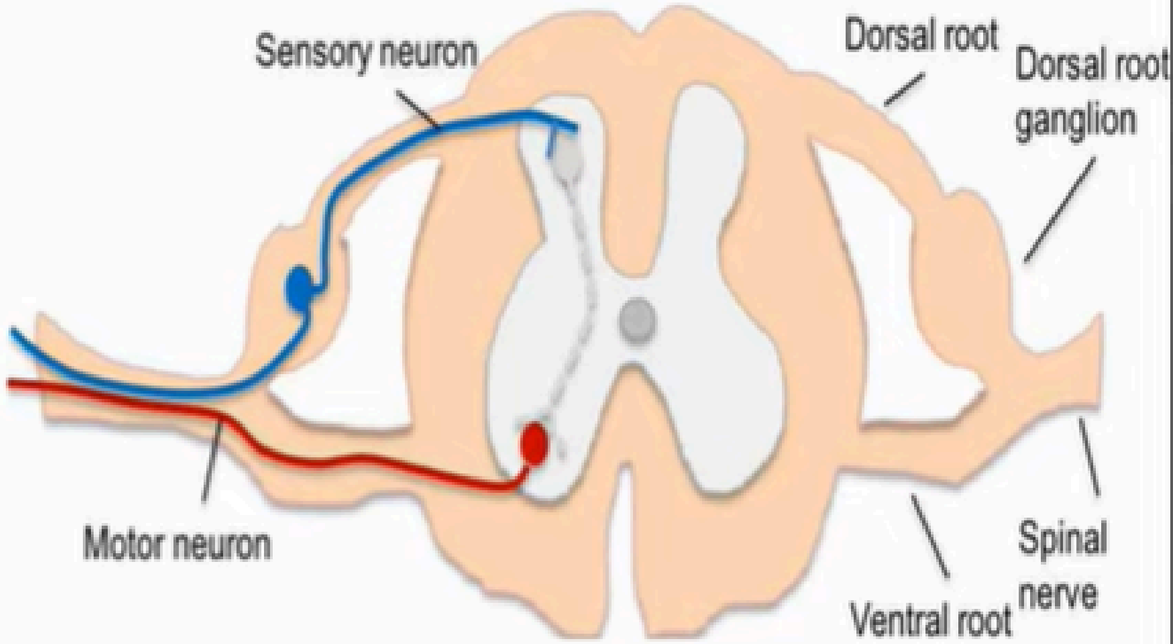
Fissure and sulci

- In the midline anteriorly, the anterior median fissure
- On the posterior surface, a shallow furrow, the posterior median sulcus.



Spinal nerves

- Along the length of the spinal cord are attached 31 pairs of spinal nerves
- Each connects to the spinal cord by **2 roots**- dorsal and ventral
- Ventral roots are motor while dorsal roots are sensory
- The 2 roots join to form spinal nerve prior to exiting the vertebral column.

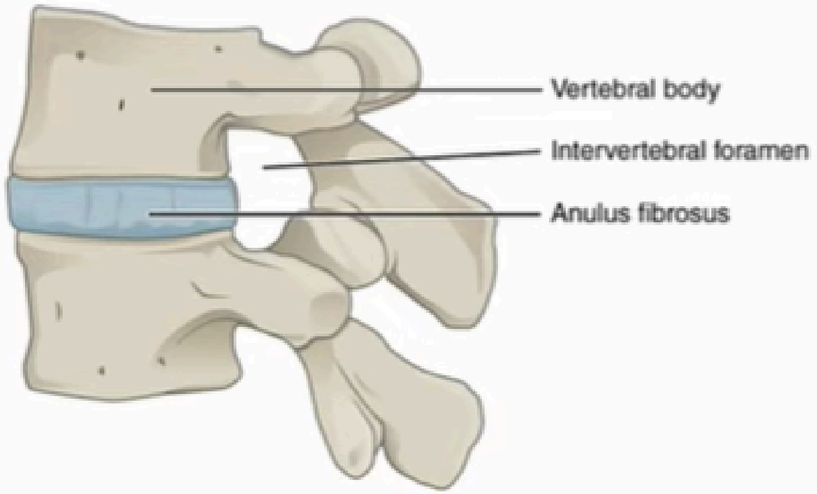


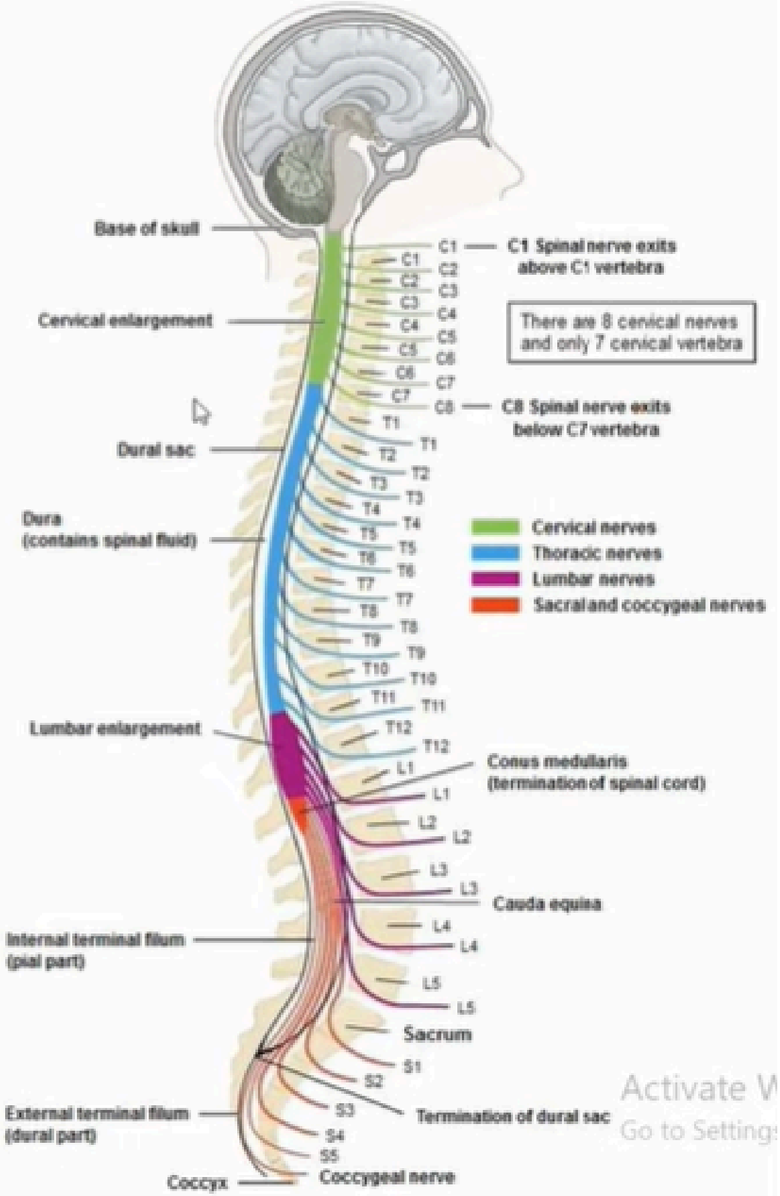
Blood supply to spinal cord

- The vertebral arteries are main source of blood to spinal cord.
- Following arteries branch from the vertebral arteries to directly supply the spinal cord-
- 1 anterior spinal artery
- 2 posterior spinal artery
- Anterior and posterior radicular artery
- Arterial vasocorona

Spinal nerves

- spinal nerves is a part of peripheral nervous system(PNS).
- There are 31 pairs of spinal nerves that originate from both sides of the spinal cord.
- These nerves leave the vertebral column by passing through the intervertebral foramina except the first spinal nerve which emerges b/w the occipital bone and atlas(first vertebra)
- Functions- receive sensory information from the periphery and pass them to the CNS. Receive motor information from the CNS and pass them to the periphery.

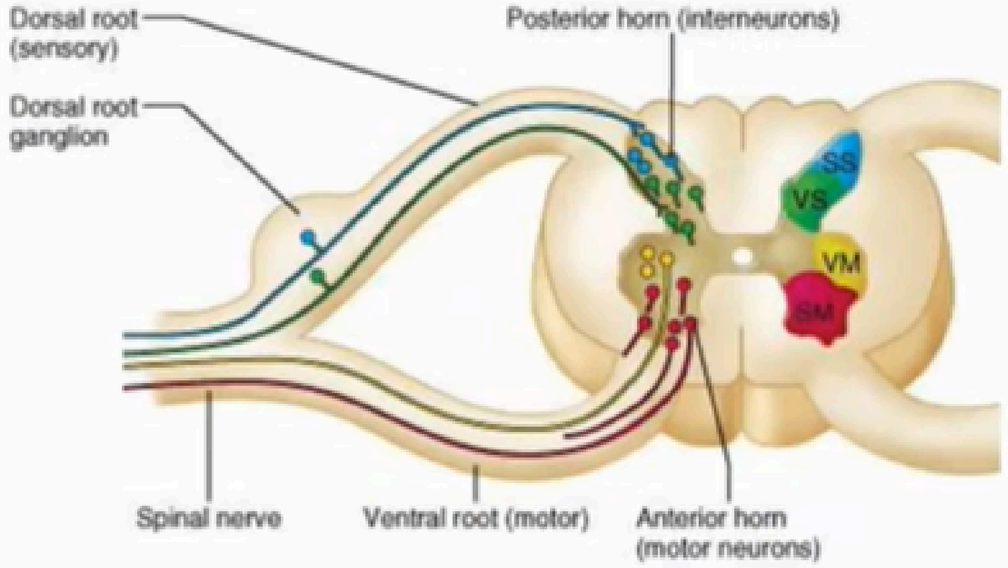




Nerve roots

- Each spinal nerve is formed by the union of a motor (anterior, ventral, efferent) and a sensory(posterior, dorsal, afferent) nerve root, therefore it is a mixed nerve.

- Just outside the spinal cord, posterior nerve root consists of spinal ganglion (posterior, dorsal root ganglion), which is a little clusters of cell bodies.

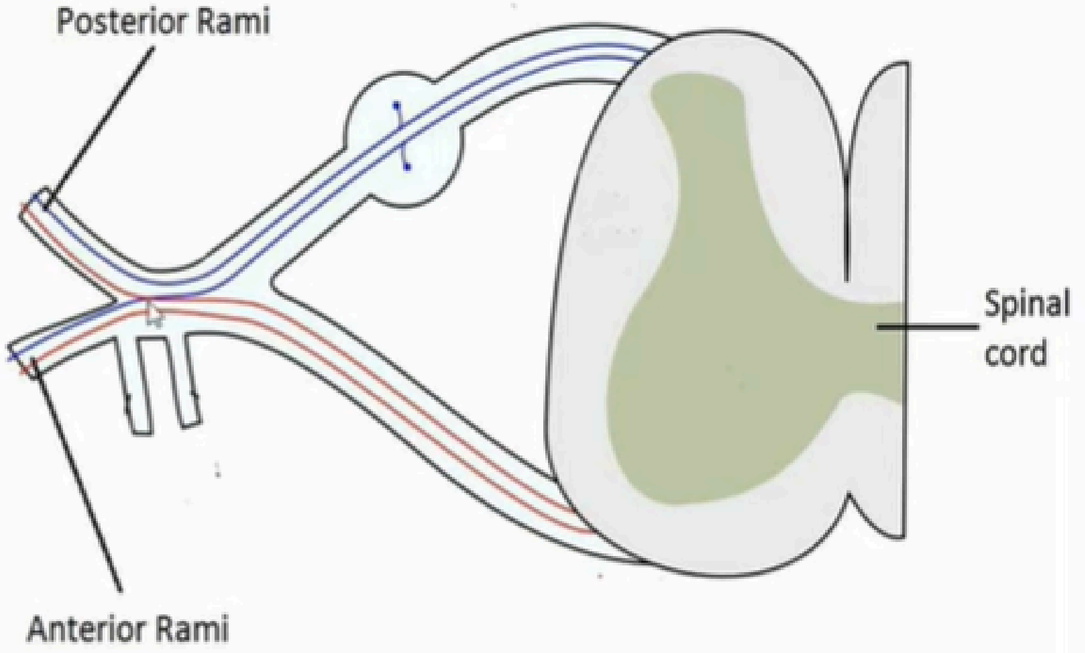


Branches of spinal nerves

- Immediately after leaving the intervertebral foramen, spinal nerves divide into two branches or rami-

1.Anterior/ventral ramus- supply the anterior and lateral aspects of skin, muscles, neck, trunk and the upper and lower limb.

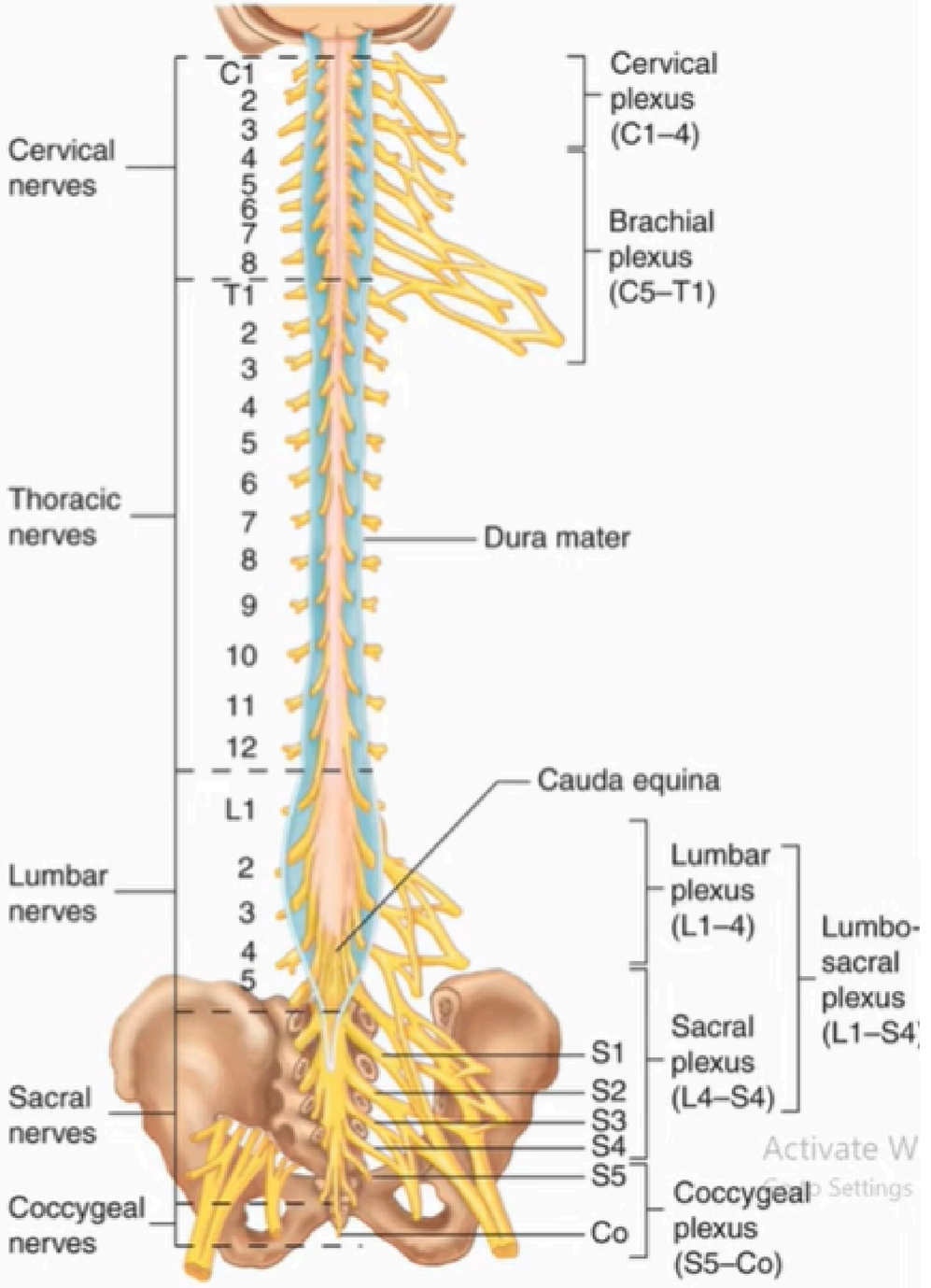
2.Posterior/dorsal ramus- supply skin and muscles of the posterior aspects of head, neck and trunk.



Plexuses

- The anterior rami unite together and form nerve networks, called plexuses.
- There are five large plexuses except thoracic region.

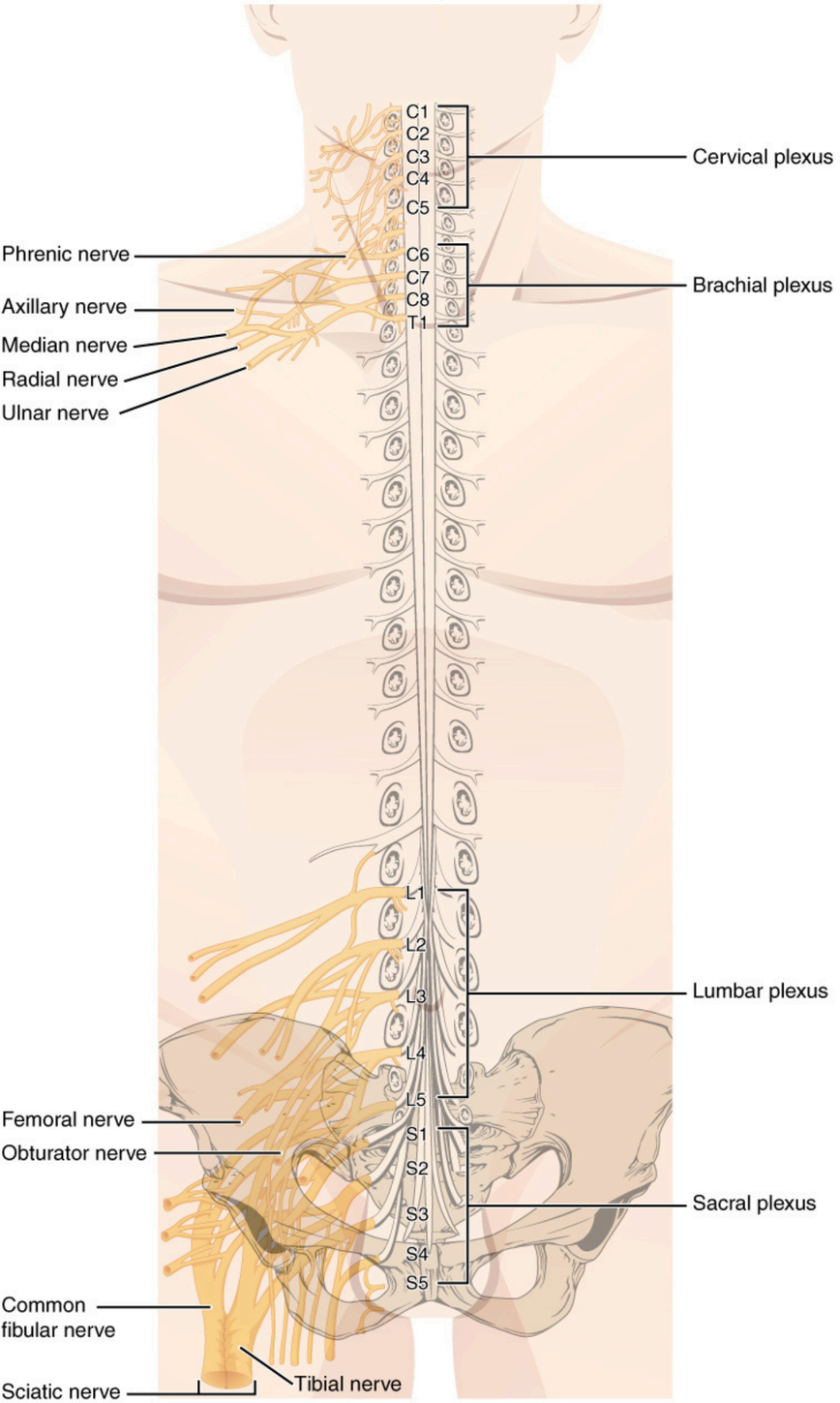
1. Cervical plexuses
2. Brachial plexuses
3. Lumbar plexuses
4. Sacral plexuses
5. Coccygeal plexuses



Thoracic nerves

- They do not intermingle to form plexus
- Out of 12 , first 11 are intercostal nerves supplying intercostal muscles and overlying skin
- 12^{th} pair form subcostal nerve- 7^{th}-12^{th} thoracic nerves supply muscle and skin of posterior and anterior abdominal muscle.

In humans there are 31 pairs: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal.



Nerve Plexuses of the Body: There are four main nerve plexuses in the human body.

The cervical plexus supplies nerves to the posterior head and neck, as well as to the diaphragm.

The brachial plexus supplies nerves to the arm.

The lumbar plexus supplies nerves to the anterior leg.

The sacral plexus supplies nerves to the posterior leg.

INTRODUCTION

Situation and Extent

Spinal cord lies loosely in the **vertebral canal.** It extends from **foramen magnum** where it is continuous with medulla oblongata, above and up to the lower border of first lumbar vertebra below.

Coverings

Spinal cord is covered by sheaths called **meninges,** which are membranous in nature. Meninges are **dura mater, pia mater** and **arachnoid mater.** These coverings continue as coverings of brain. Meninges are responsible for protection and nourishment of the nervous tissues.

Shape and Length

Spinal cord is cylindrical in shape. Length of the spinal cord is about 45 cm in males and about 43 cm in females.

Segments

Spinal cord is made up of 31 segments, which are listed in Box 140.1. In fact, spinal cord is a continuous structure. Appearance of the segment is by nerves arising from spinal cord, which are called spinal nerve.

BOX 140.1: Segments of spinal cord and spinal nerves

Spinal segments/Spinal nerves		
1. Cervical segments/Cervical spinal nerves	=	8
2. Thoracic segments/Thoracic spinal nerves	=	12
3. Lumbar segments/Lumbar spinal nerves	=	5
4. Sacral segments/Sacral spinal nerves	=	5
5. Coccygeal segment/Coccygeal spinal nerves	=	1
Total	=	31

Spinal Nerves

A spinal nerve is a mixed nerve consisting of both motor and sensory fibers that carry the information between spinal cord and specific regions of the body. These nerves form a part of peripheral nervous system. In humans there are 31 pairs of spinal nerves corresponding to the segments of spinal cord in a symmetrical manner. The spinal nerves are listed in Box 140.1.

Spinal Nerve Roots

Each spinal nerve is formed by two nerve roots.

1. *Posterior or dorsal root*

It is formed by afferent sensory nerve fibers which carry sensory information from different parts of the body to spinal cord and brain. Posterior root has a small bulging called posterior root ganglion which is formed by the soma of neurons. Dendrites of these neurons form sensory nerve fibers. And their axons reach the spinal cord.

2. *Anterior or ventral root*

This root is formed by efferent motor nerve fibers that carry motor information from brain and spinal cord to different parts of the body.

Both the nerve roots on either side leave the spinal cord and pass through the corresponding **intervertebral foramina.** Roots of the first **cervical** spinal nerves pass through a foramen between occipital bone and first vertebra, which is called **atlas.** Cervical and thoracic roots are shorter whereas, the lumbar and sacral roots are longer. Long nerves descend in dural sac to reach their respective intervertebral foramina. This bundle of descending roots surrounding the **filum terminale** resembles the tail of horse. Hence, it is called **cauda equina.**

Branches of Spinal Nerves

After formation by dorsal and ventral roots, each spinal nerve divides into four branches.

1. *Posterior or dorsal ramus*

This ramus carries somatic motor fibers, somatic sensory fibers and visceral motor fibers. Posterior rami are smaller than anterior rami and supply the muscles, joints and skin of posterior part of the trunk.

2. *Anterior or ventral ramus*

Anterior ramus carries somatic motor fibers, somatic sensory fibers and visceral motor fibers. Anterior rami are larger than posterior rami and supply the muscles, joints and skin of anterior and lateral parts of trunk and upper and lower limbs.

3. *Meningeal branch*

This branch carries somatic motor, somatic sensory and visceral motor fibers. All the meningeal branches arise from initial part of spinal nerves and run back through intervertebral foramen to supply spinal meninges, ligaments, dura, blood vessels, facet joints, intervertebral disks and periosteum of the vertebra.

4. *Rami communicantes*

Rami communicantes (singular = ramus communicans) are the branches communicating between spinal nerves and sympathetic division of autonomic nervous system. There are two rami communicantes namely, gray ramus communicans and white ramus communicans. **Gray rami communicantes** carry fibers from sympathetic chain to all the 31 pairs of spinal nerves. **White rami communicantes** carry fibers from all thoracic and first two lumbar spinal nerves to sympathetic chain. Rami communicantes carry visceral motor and visceral sensory information to and from visceral organs.

Spinal Nerve Plexuses

Spinal nerve plexus is a bundle of fibers from adjacent spinal nerves that forming a network. There are five plexuses which consist of both sensory and motor nerves fibers.

1. *Cervical plexus*

Cervical plexus is formed by the anterior rami of 1st to 4th cervical spinal nerves with a small contribution from the 5th cervical nerve. It supplies head, neck, shoulder and chest.

2. *Brachial plexus*

It is formed by anterior rami of 5th to 8th cervical and 1st thoracic nerves. It gives rise to five nerves, viz. musculocutaneous nerve, axillary nerve, radial nerve, median nerve and ulnar nerve. It supplies hand, arm, chest and shoulder.

3. *Lumbar plexus*

It is formed by anterior rami of 1st to 4th lumbar nerves. Femoral nerve and obturator nerve are the two important nerves arising from this plexus. Lumbar plexus supplies anterolateral part of abdominal wall, external genitalia and part of lower limb.

4. *Sacral plexus*

Sacral plexus is formed by anterior rami of 4th and 5th lumbar nerves and 1st to 4th sacral nerves.

Important nerves arising from this plexus are sciatic nerve, pudendal nerve and gluteal nerves. Sacral plexus supplies buttocks, perineum and lower limb.

5. *Coccygeal plexus*

It is formed by anterior rami of 4th and 5th sacral nerves and coccygeal nerve. It supplies coccygeal region.

■ GRAY MATTER OF SPINAL CORD

Gray matter of spinal cord is the collection of nerve cell bodies, dendrites and parts of axons. It is placed centrally in the form of **wings of the butterfly** and it resembles the letter 'H'. Exactly in the center of gray matter, there is a canal called the **spinal canal.**

Ventral and the dorsal portions of each lateral half of gray matter are called ventral (anterior) and dorsal (posterior) gray horns respectively. In addition, the gray matter forms a small projection in between the anterior and posterior horns in all thoracic and first two lumbar segments. It is called the lateral gray horn. Part of the gray matter anterior to central canal is called the **anterior gray commissure** and part of gray matter posterior to the central canal is called **posterior gray commissure.**

Neurons in Gray Matter of Spinal Cord

Gray matter contains two types of multipolar neurons.

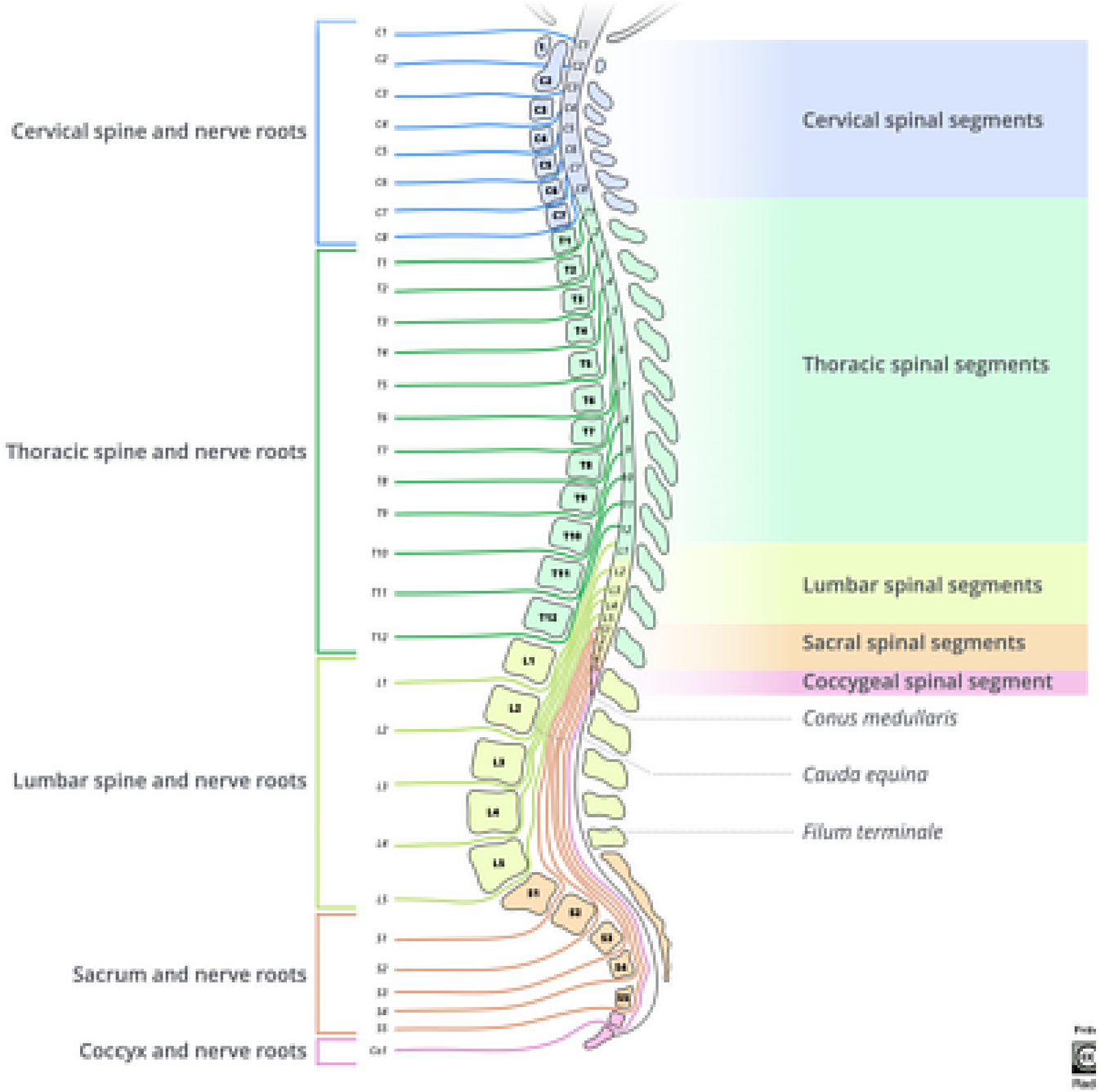
1. *Golgi type I neurons*

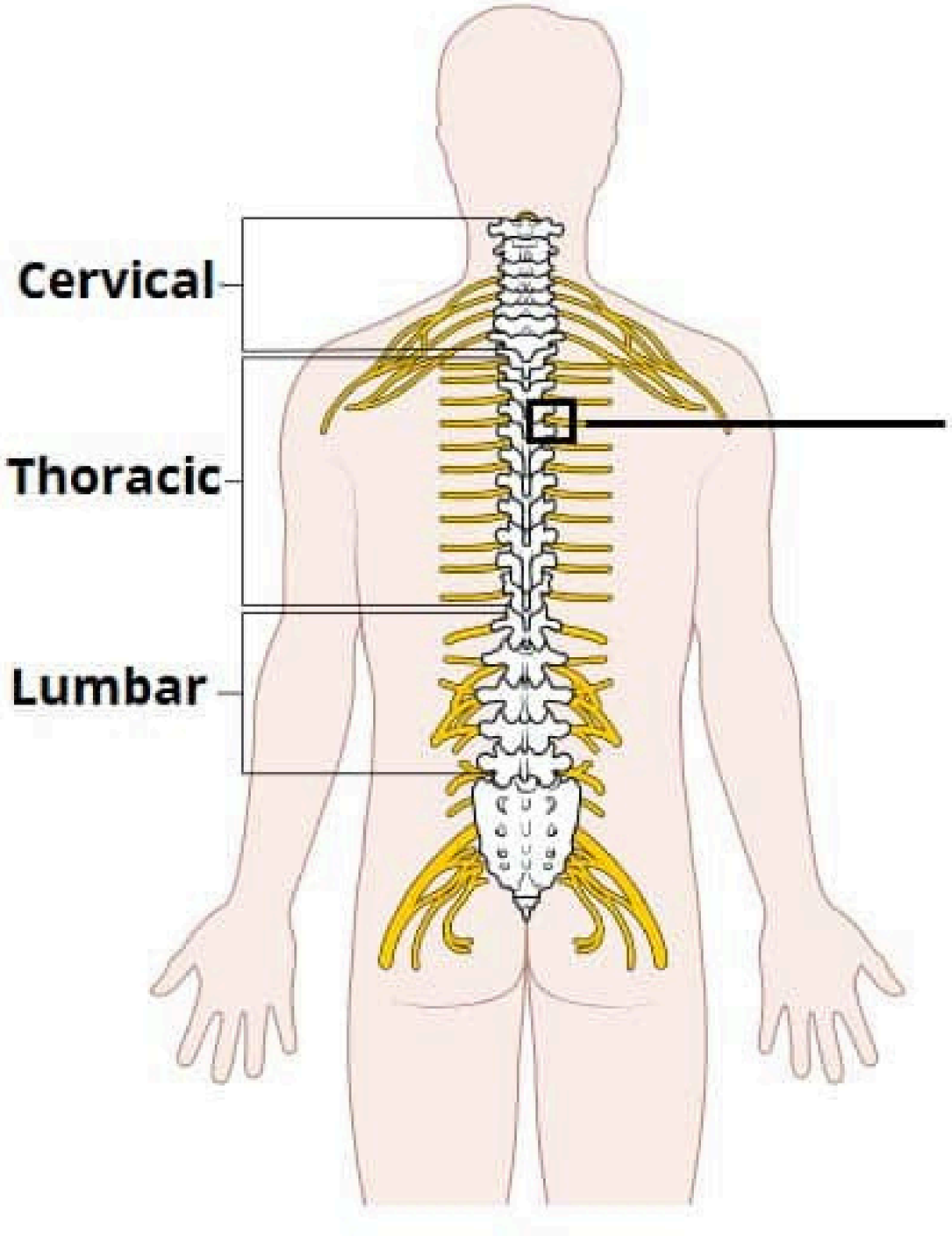
Golgi type I neurons have **long axons** and are usually found in anterior horns. Axons of these neurons form the long tracts of spinal cord.

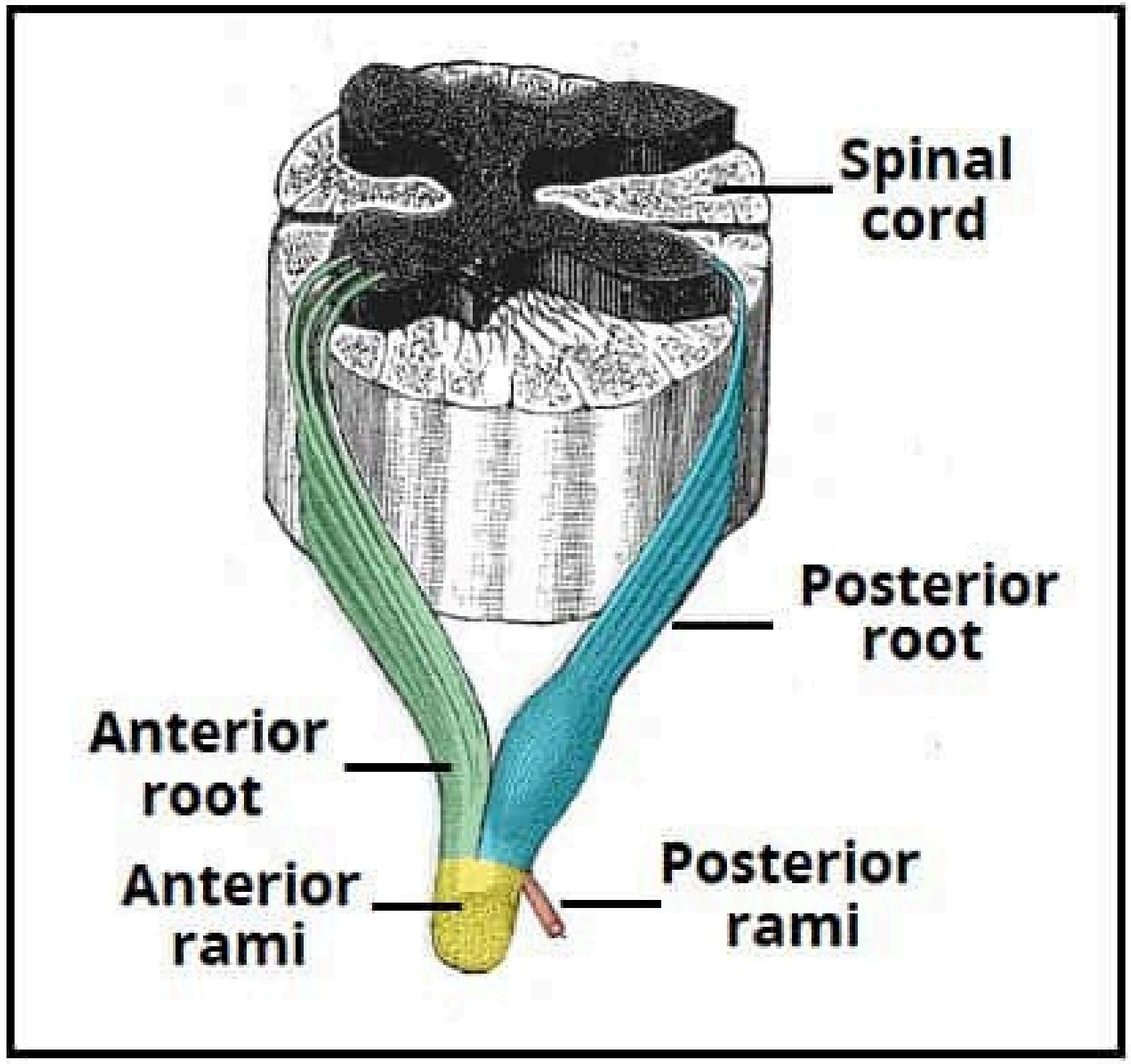
2. *Golgi type II neurons*

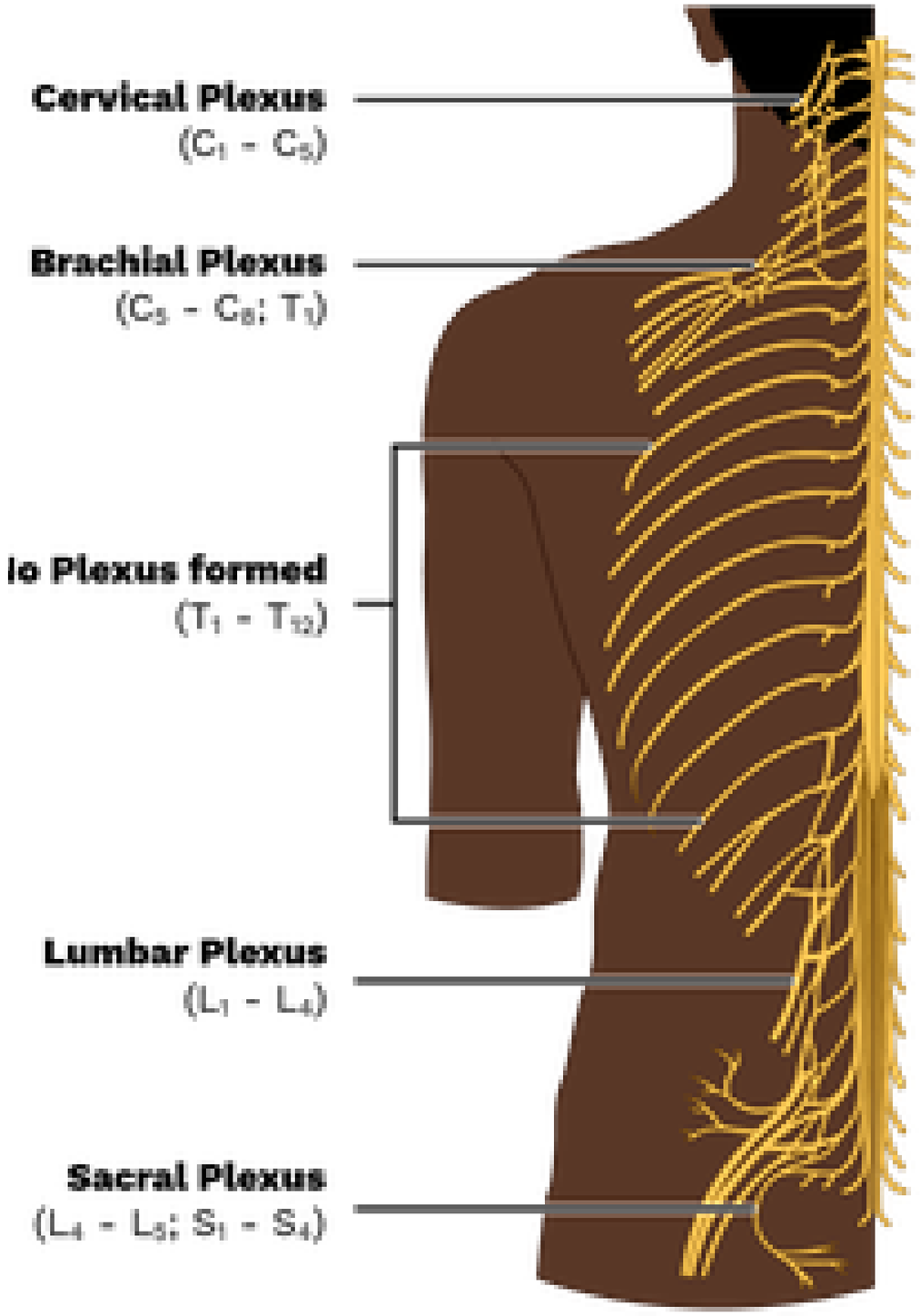
Golgi type II neurons have **short axons,** which are found mostly in posterior horns. Axons of these neurons pass towards the anterior horn of same side or opposite side.

Vertebral bodies and spinal cord

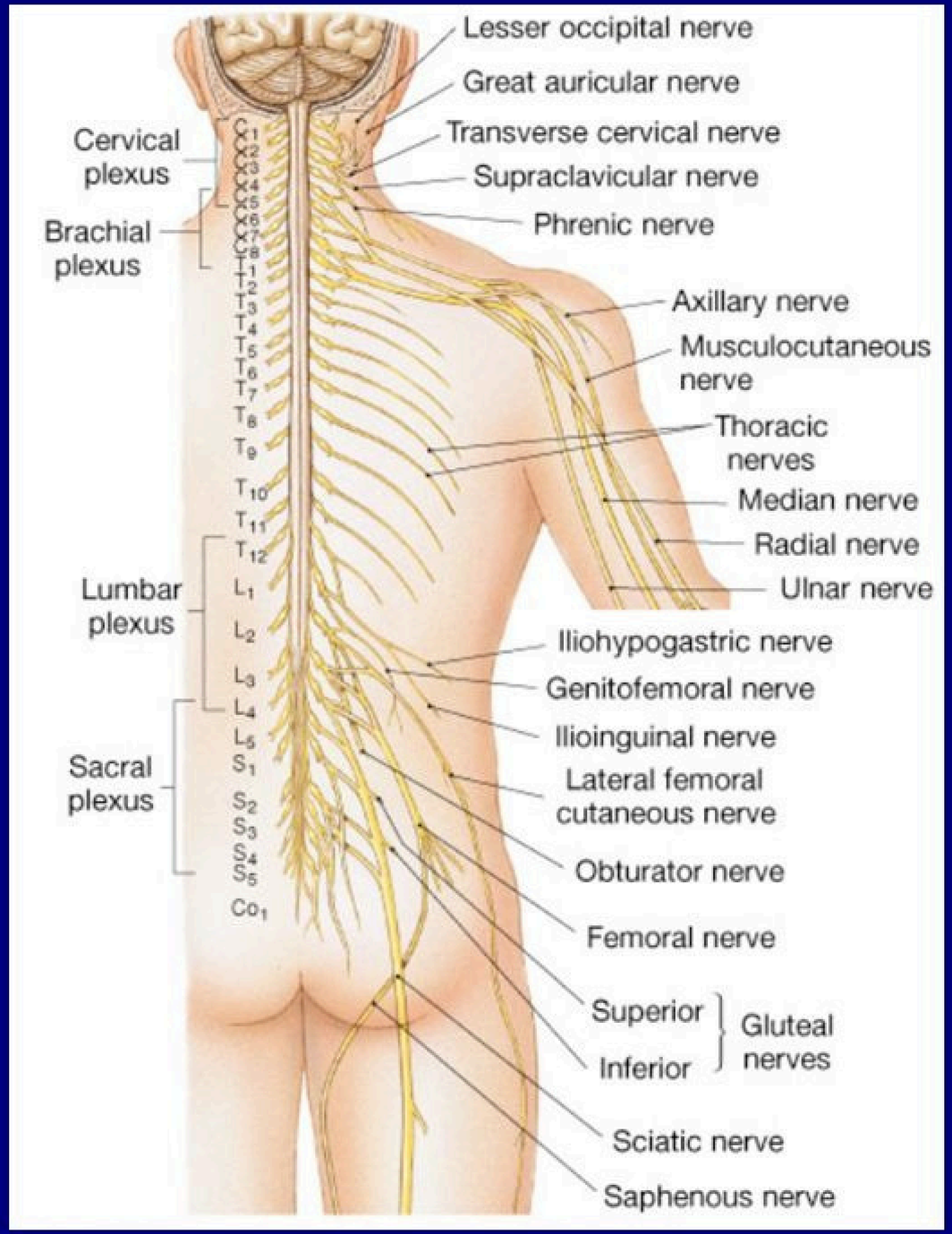



Cervical
Thoracic
Lumbar


Spinal cord
Posterior root
Anterior root
Anterior rami
Posterior rami



Nerve Plexus	Ventral Rami	Body Area Served
Cervical Plexus	C_1 - C_5	Head and neck
Brachial Plexus	C_5 - T_1	Upper limb
Lumbar Plexus	L_1 - L_4	Abdomen and lower limb
Sacral Plexus	L_4 - S_4	Pelvis, perineum, and lower limb

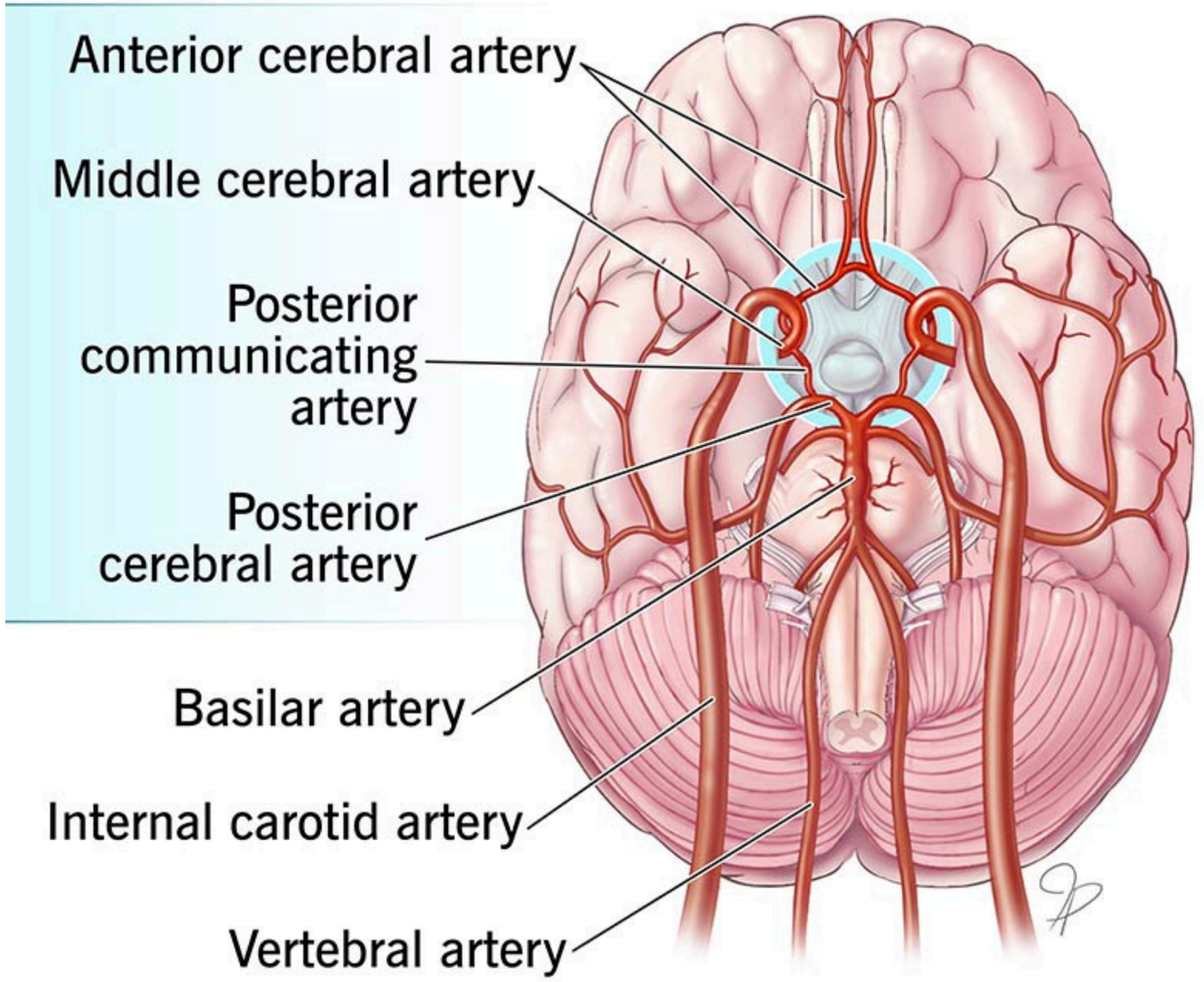


Spinal Nerve Plexus

- Nerve plexus:
  - Interwoven network of nerves

1. Cervical plexus:
   - Nerves C1-C5
   - Innervate muscles of neck and diaphragm
2. Brachial plexus:
   - Nerve C5-T1
   - Innervate pectoral girdle and upper limbs
3. Lumbar plexus:
   - Nerves T12-L4
   - Innervate pelvic girdle and lower limbs
4. Sacral plexus:
   - Nerves L4-S4
   - Innervate lower limbs

Circle of Willis



Bottom view of brain

INTRODUCTION TO THE MENINGES

Definition: The meninges are three layers of connective tissue that protect the brain and spinal cord.

Layers:

- **Dura Mater:** Outer, tough fibrous layer.
- **Arachnoid Mater:** Middle, web-like membrane.
- **Pia Mater:** Inner, delicate layer closely adhering to the brain's surface.
- **Functions:** Protection, support for blood vessels, and CSF circulation

DETAILED ANATOMY OF THE MENINGES

- **Dura Mater:** Thick and inelastic, forms two layers (periosteal and meningeal), creates dural folds like the falx cerebri and tentorium cerebelli.
- **Arachnoid Mater:** Web-like extensions to the pia mater, subarachnoid space contains CSF.
- **Pia Mater:** Thin, vascular layer providing nutrients to brain tissue.

DURA MATTER (made up of)

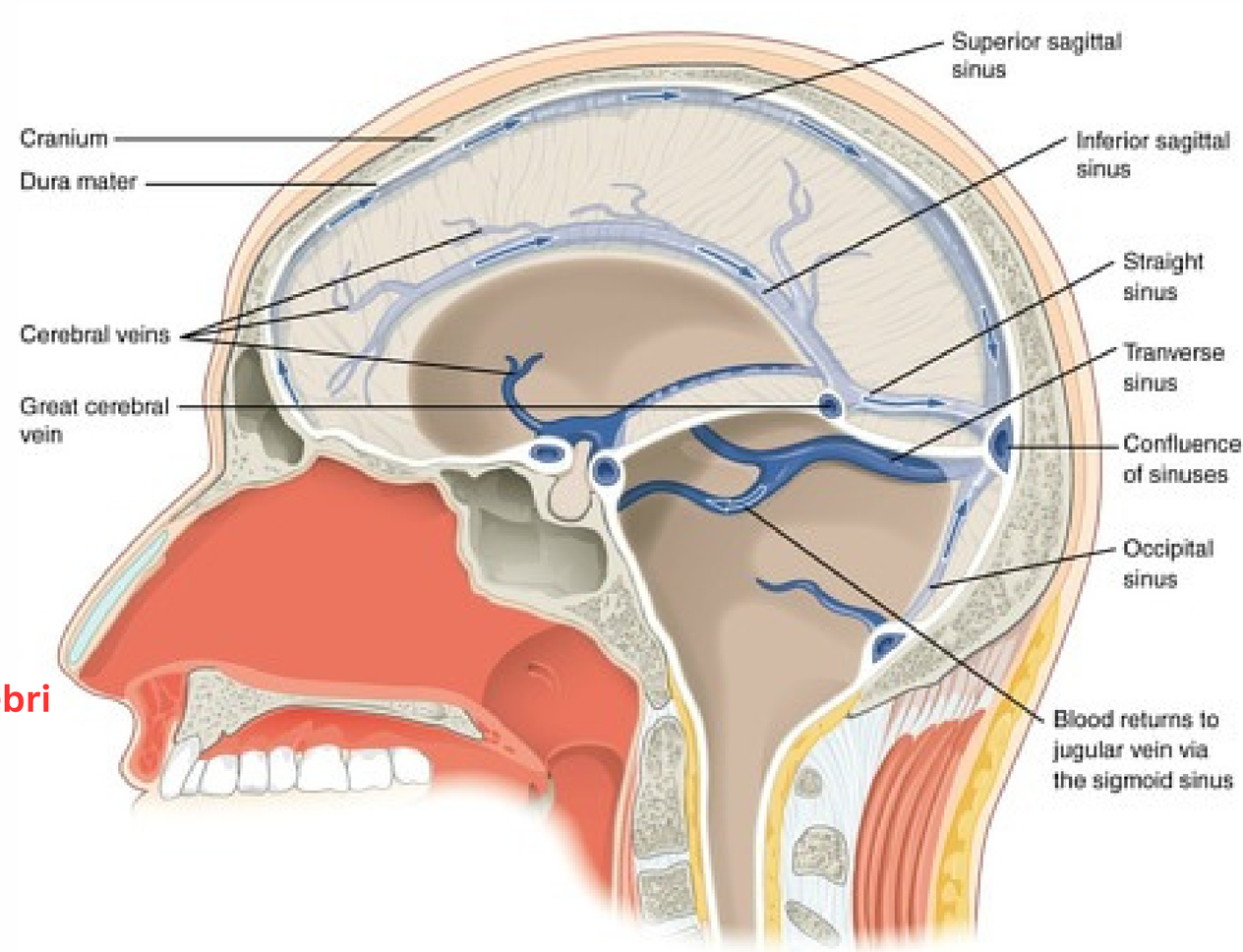
OUTER PERIOSTEAL LAYER

- tough fibrous connective tissue connects meninges to skull and vertebrae
- Inner meningeal layer

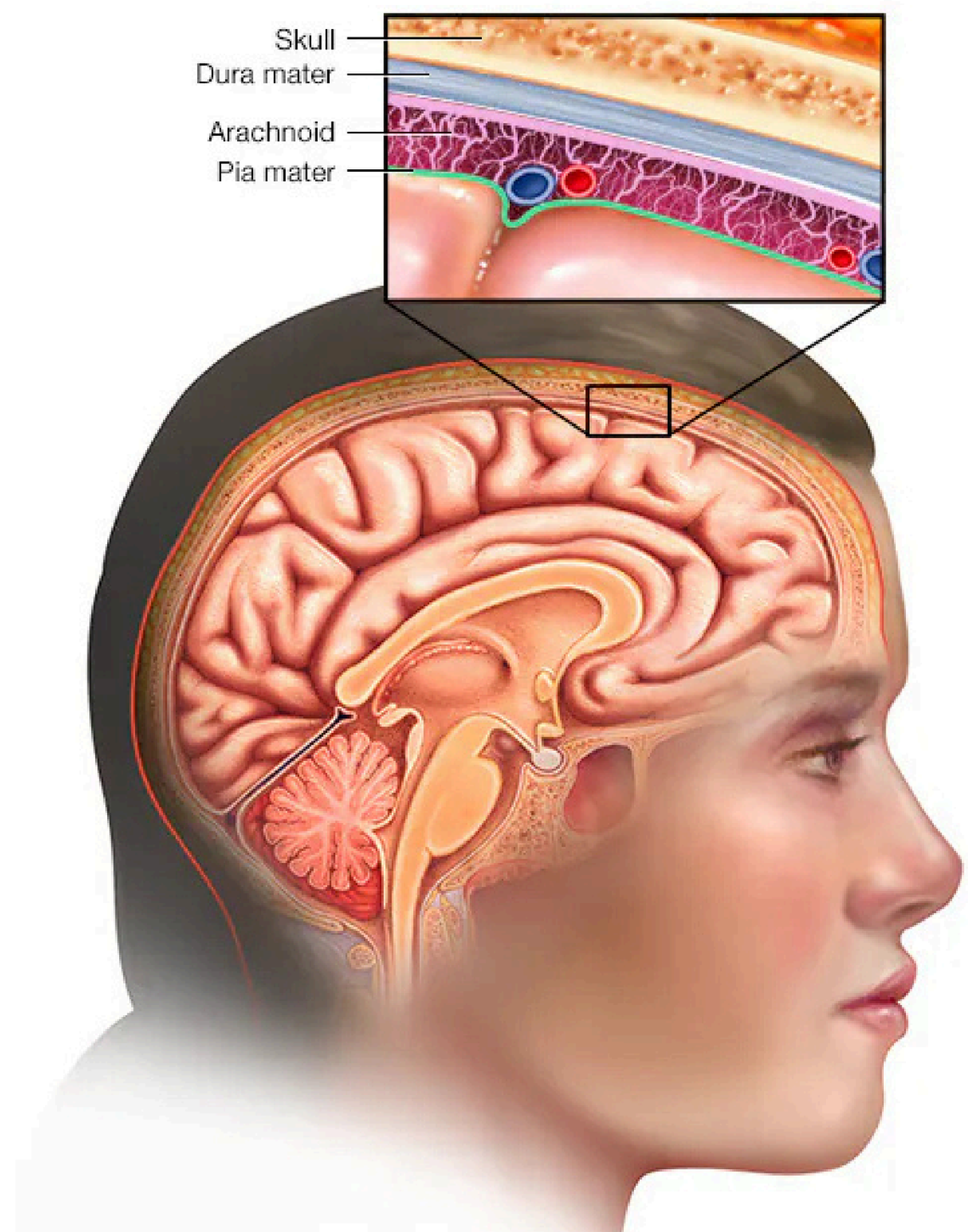
INNER MENINGEAL LAYER(DURA LAYER)

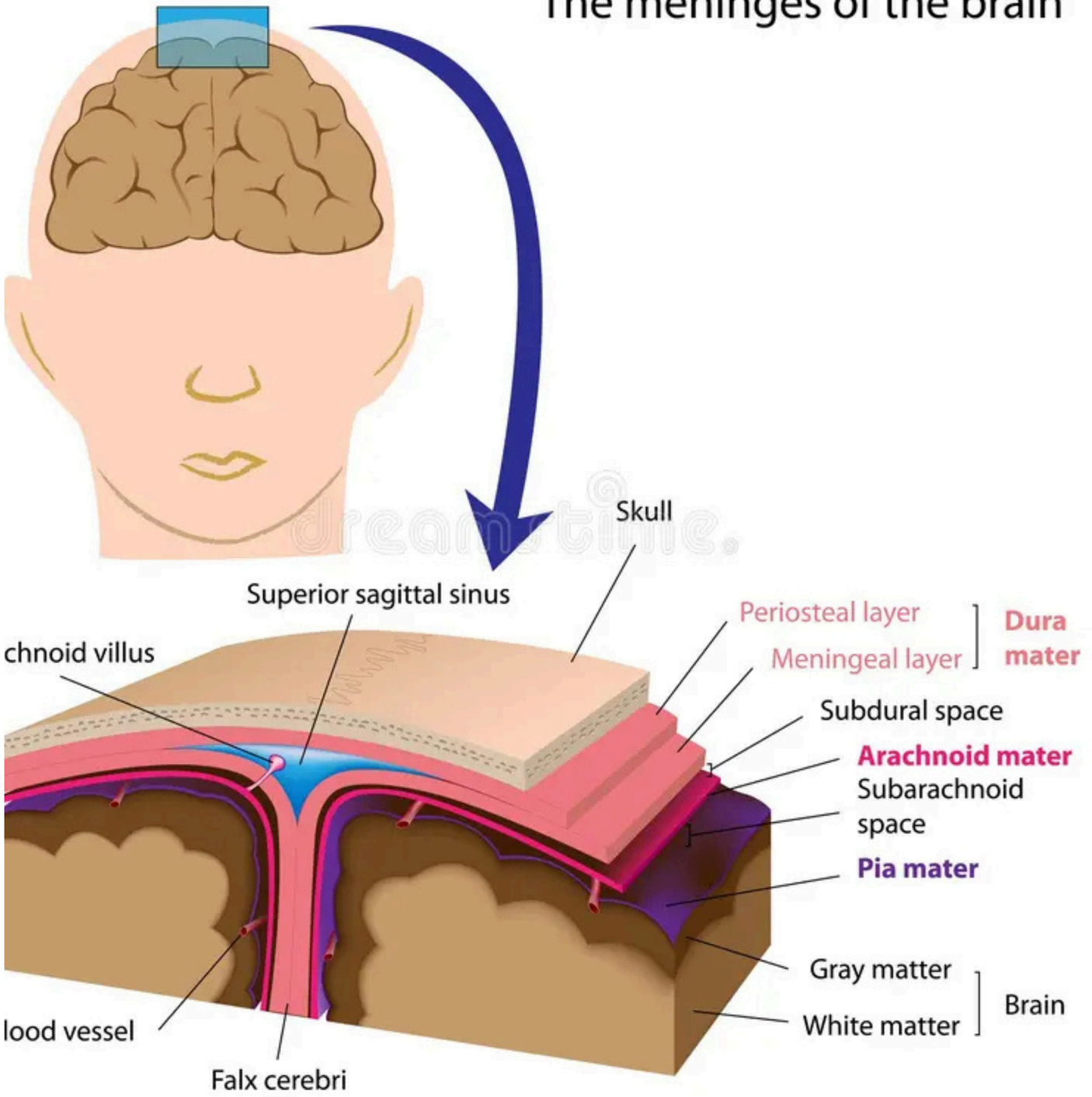
- forms infoldings that divide cranial cavity into different compartments
- support various subdivisions of brain

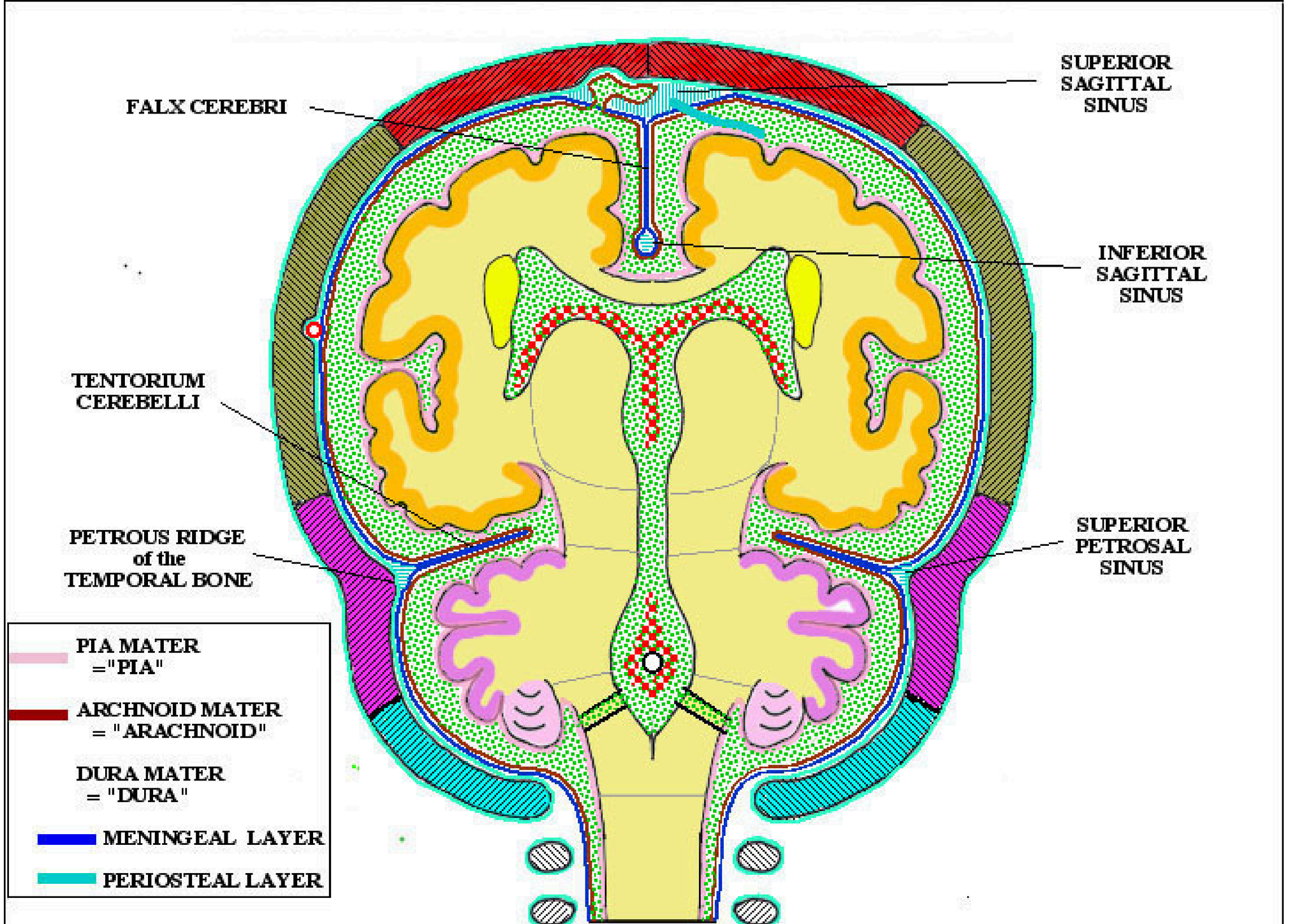
- Between cerebral hemisphere Falx Cerebri
- Between cerebral hemisphere Falx Cerebri
- Between cerebrum and cerebellum Tentorium cerebri

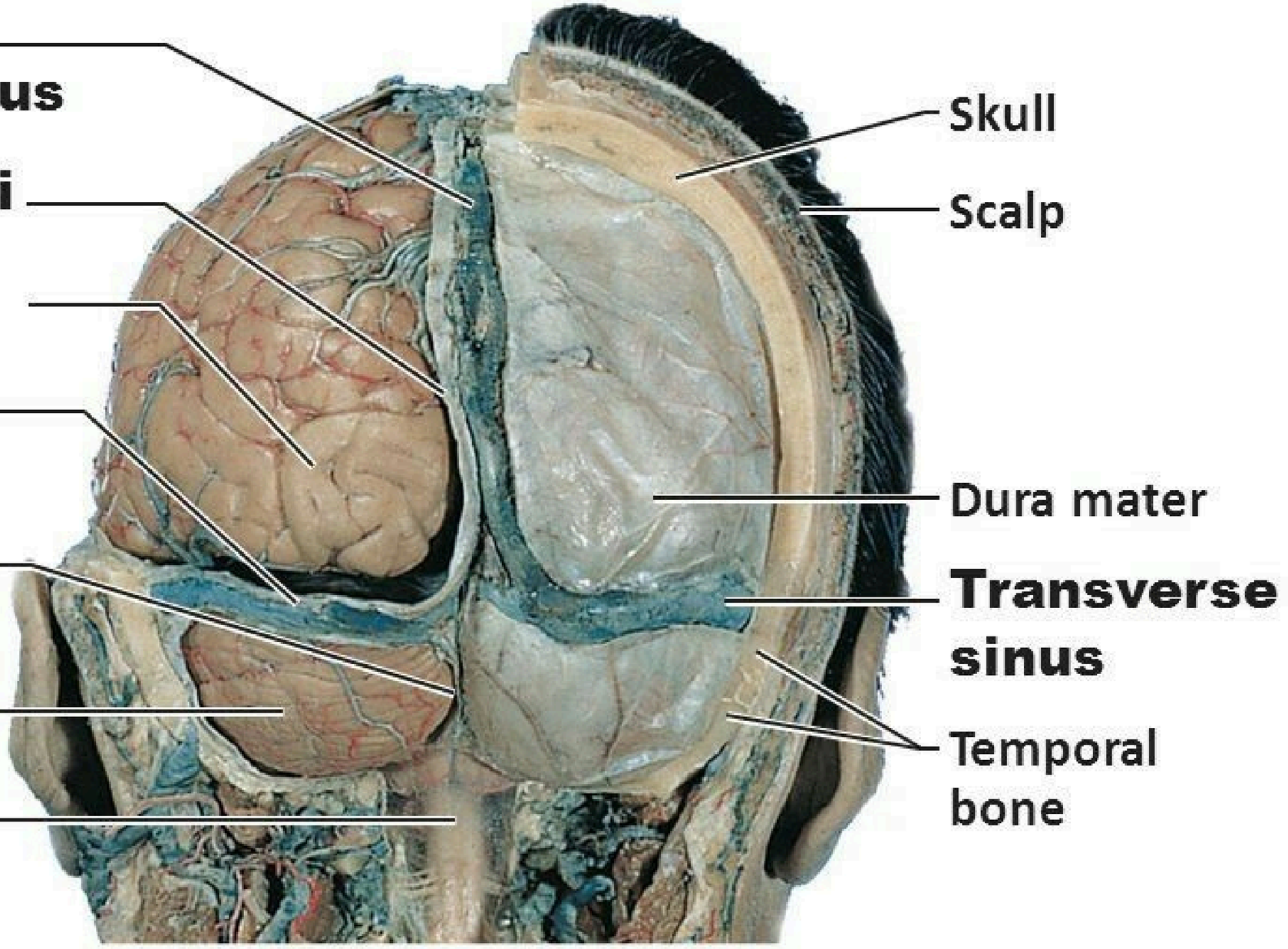


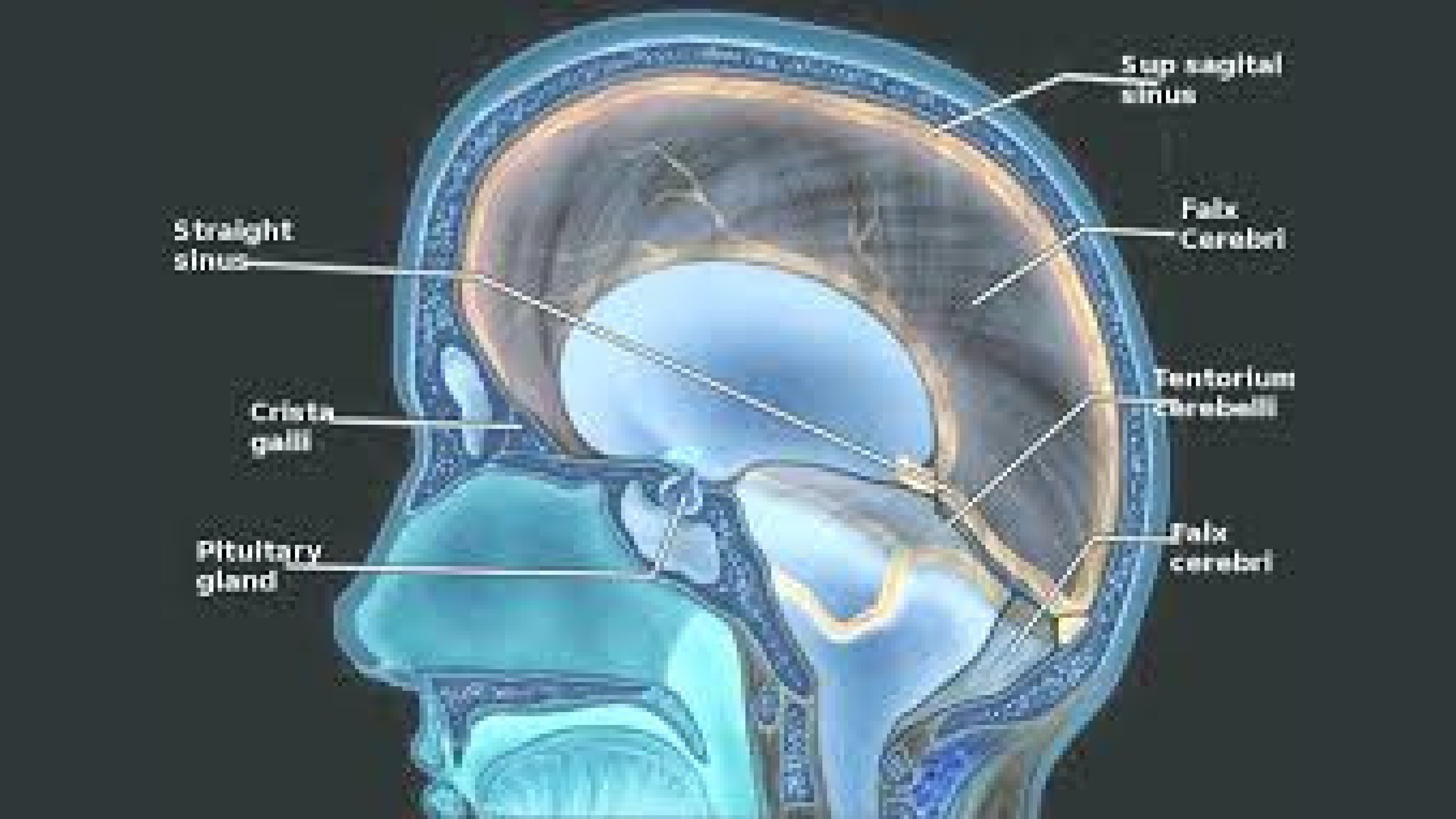
The meninges of the brain

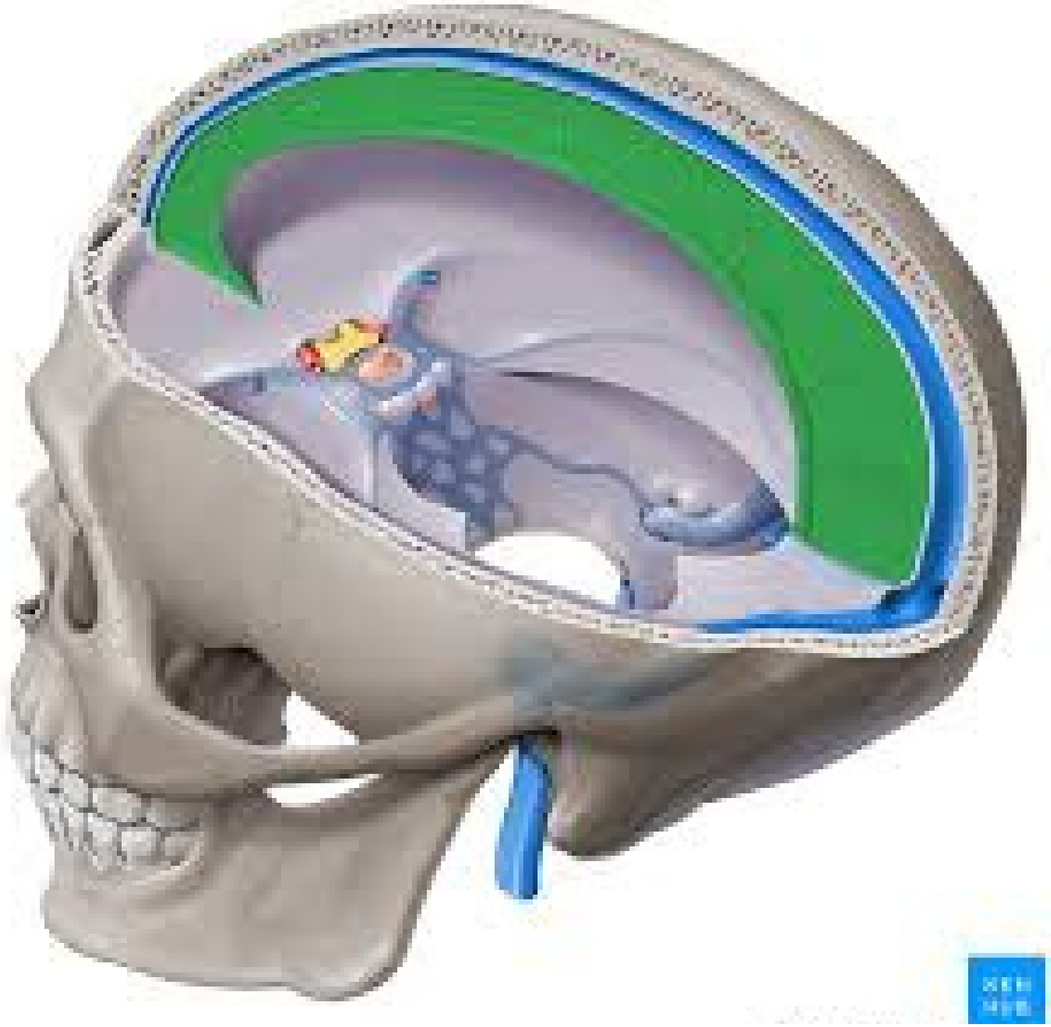


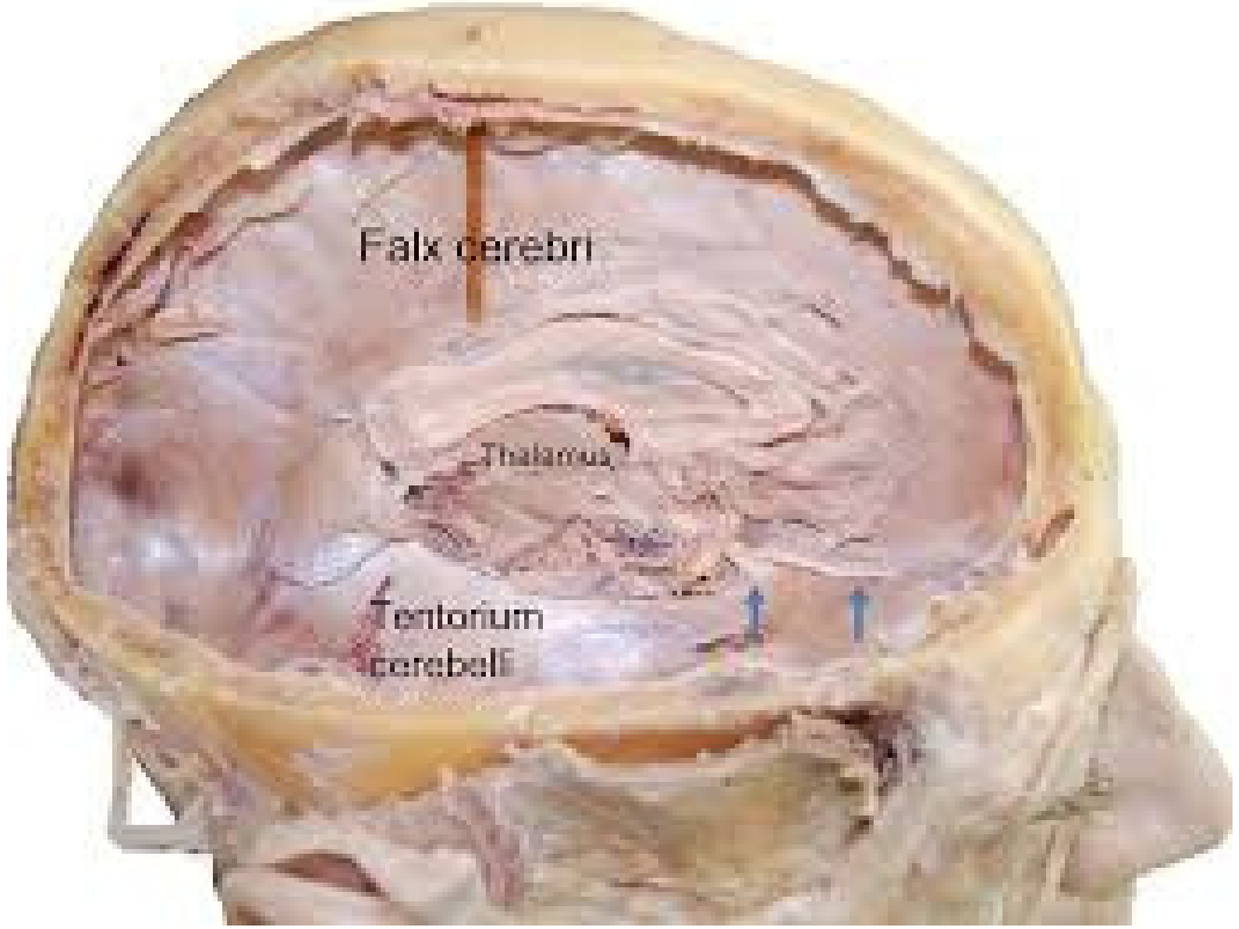



FALX CEREBRI
SUPERIOR SAGITTAL SINUS
INFERIOR SAGITTAL SINUS
TENTORIUM CEREBELLI
PETROUS RIDGE of the TEMPORAL BONE
SUPERIOR PETROSAL SINUS
PIA MATER ="PIA"
ARCHNOID MATER = "ARACHNOID"
DURA MATER = "DURA"
MENINGEAL LAYER
PERIOSTEAL LAYER


Superior sagittal sinus
Falx cerebri
Occipital lobe
Tentorium cerebelli
Falx cerebelli
Cerebellum
Arachnoid mater over medulla oblongata
Skull
Scalp
Dura mater
Transverse sinus
Temporal bone

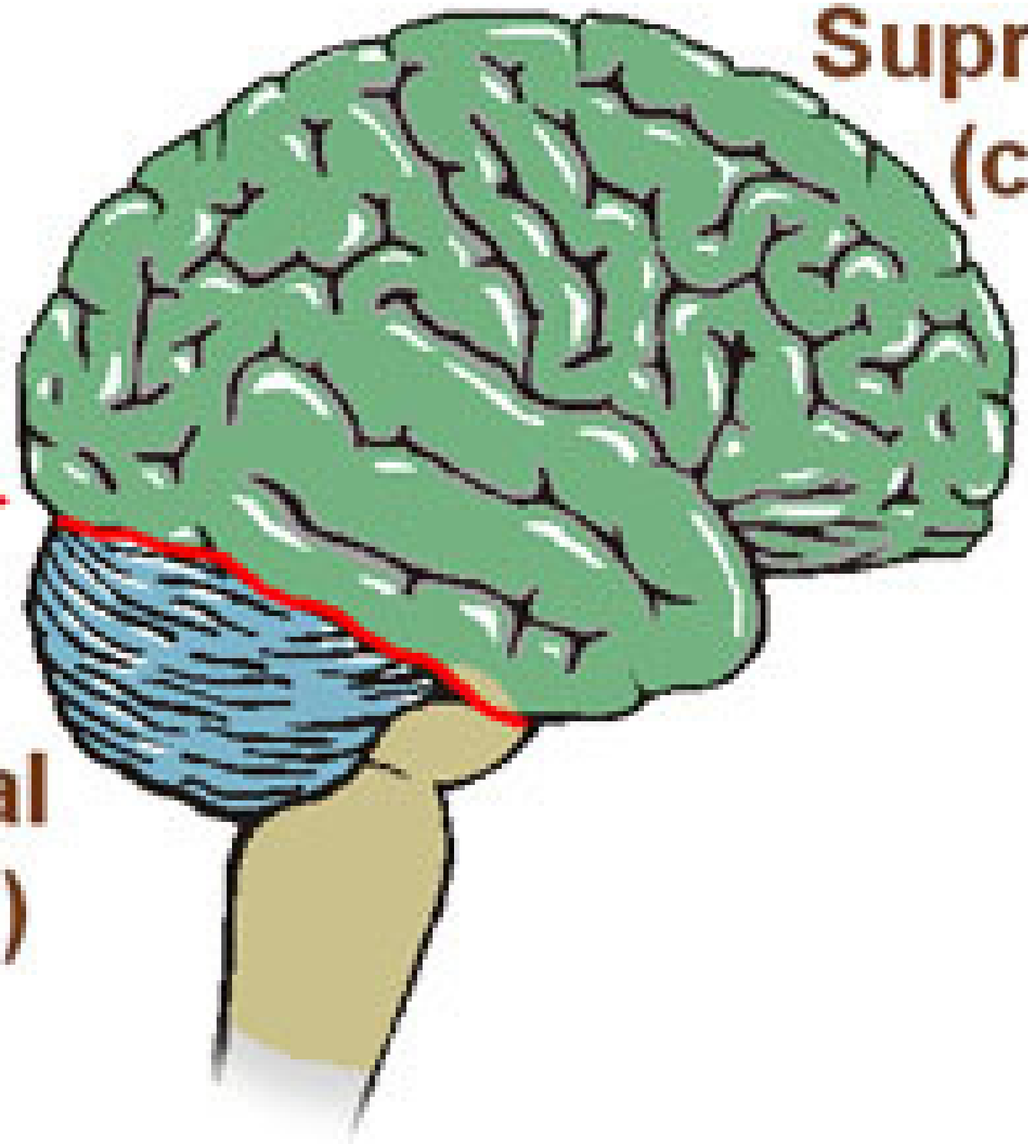

Sup sagital sinus
Straight sinus
Falx Cerebri
Crista galli
Tentorium cerebelli
Pituitary gland
Falx cerebri



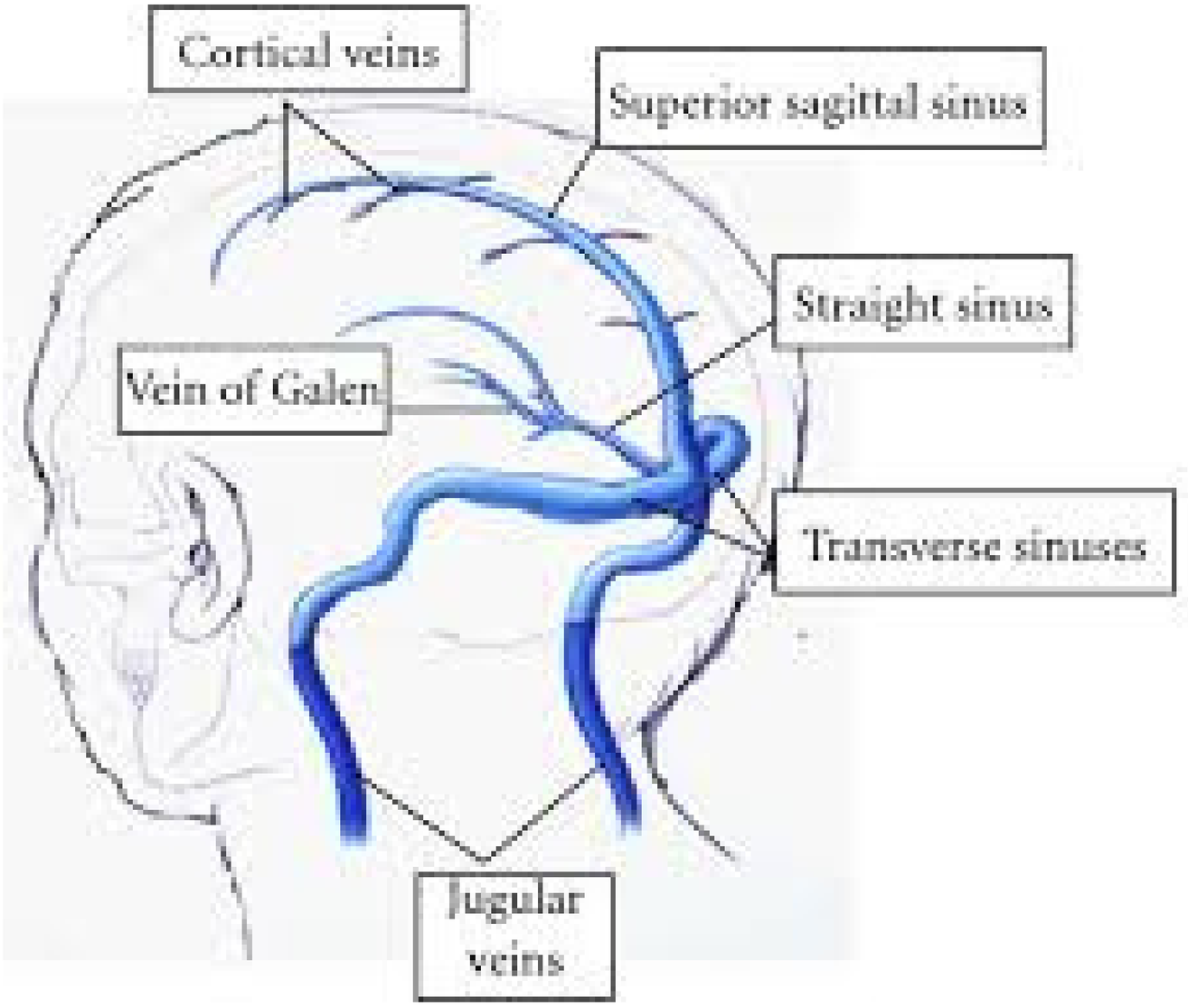


The **falx cerebri** (also known as the cerebral falx) is a **large, crescent-shaped fold of dura mater that descends vertically into the longitudinal fissure to separate the cerebral hemispheres**. It supports the dural sinuses that provide venous and CSF drainage from the brain.

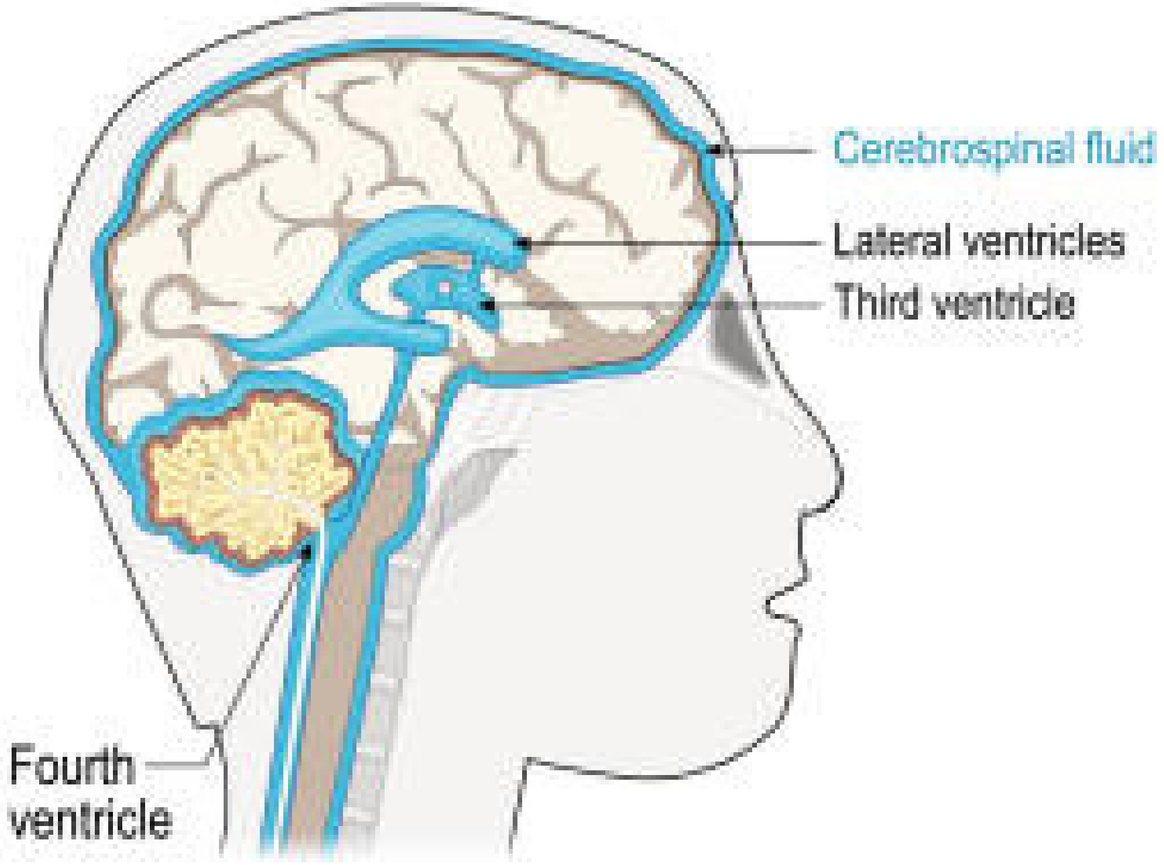
The Tentorium Cerebelli

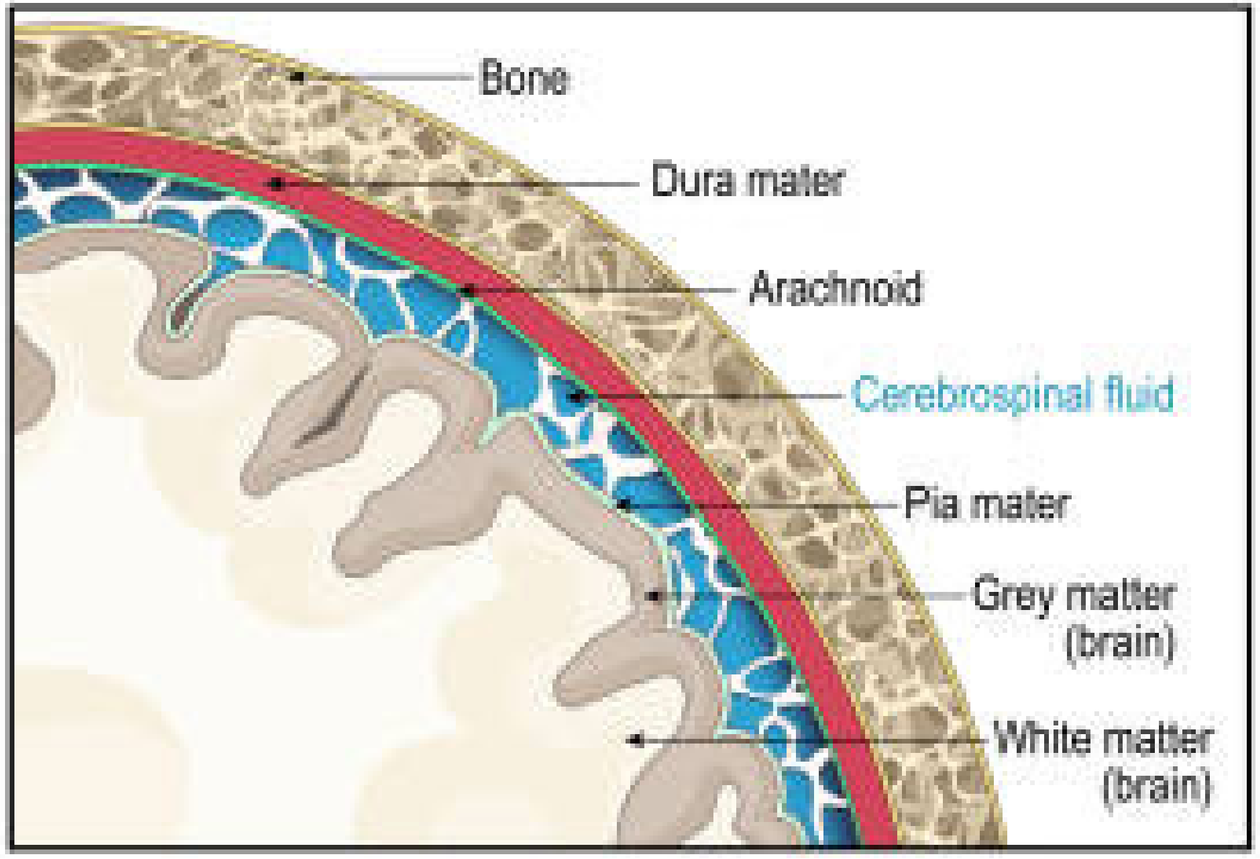


The tentorium cerebelli is an **invagination of dura mater that separates the occipital and temporal lobes of the cerebrum from the cerebellum and brainstem.**


Cortical veins
Superior sagittal sinus
Straight sinus
Vein of Galen
Transverse sinuses
Jugular veins

Cerebrospinal fluid



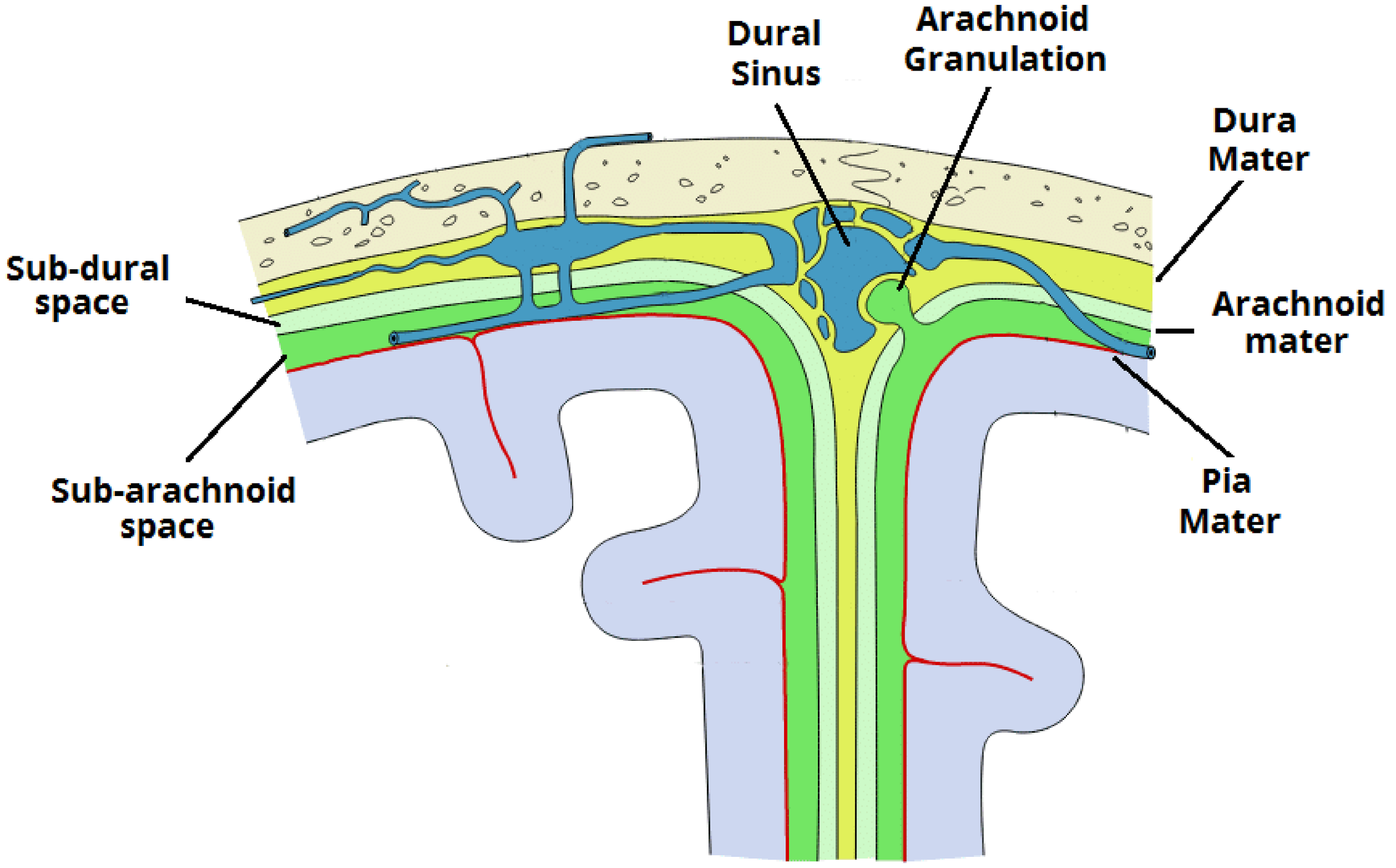


MENINGEAL SPACES

- **Epidural Space:** Potential space between the dura mater and skull.
- **Subdural Space:** Space between the dura and arachnoid mater.
- **Subarachnoid Space:** Contains CSF, lies between the arachnoid and pia mater.
- **Clinical Note:** Hemorrhages in these spaces (e.g., epidural, subdural, subarachnoid hemorrhages).

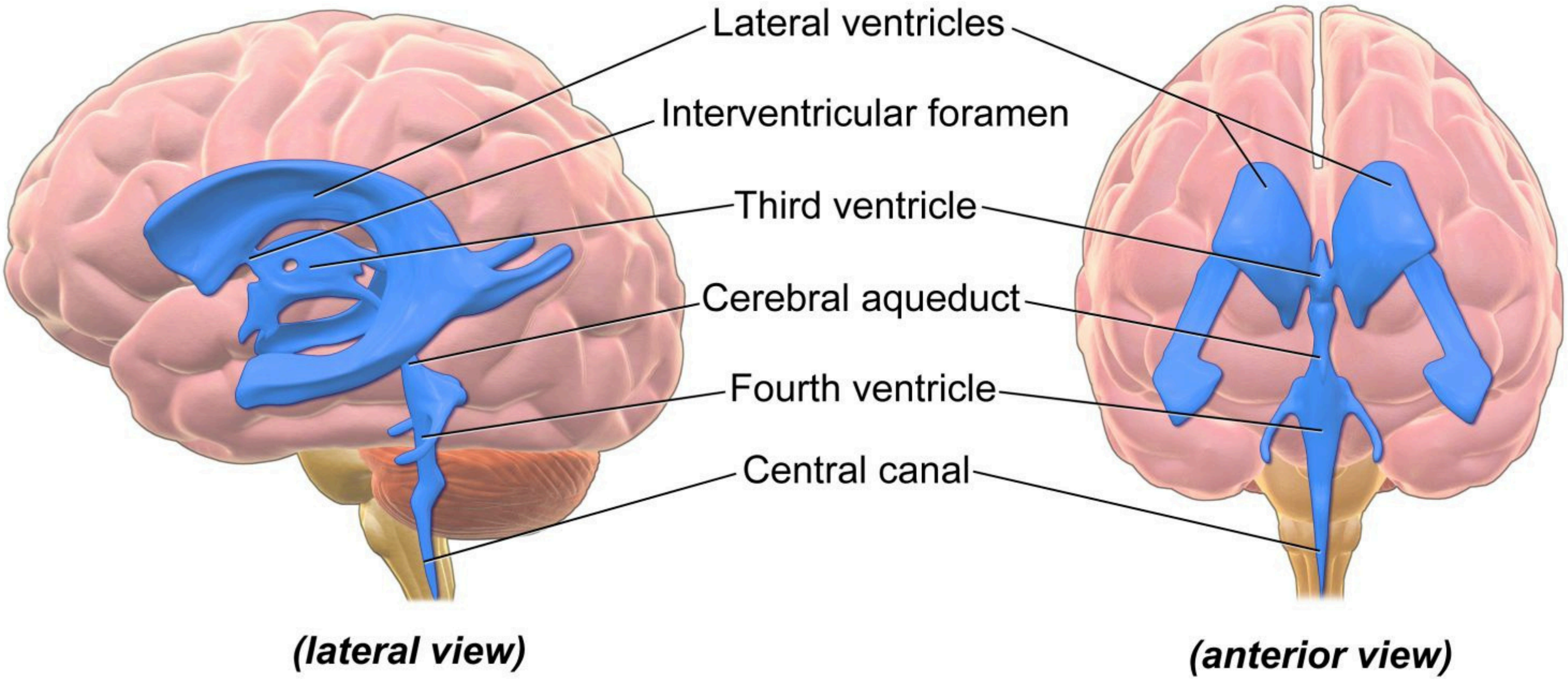
FUNCTIONS OF CEREBROSPINAL FLUID

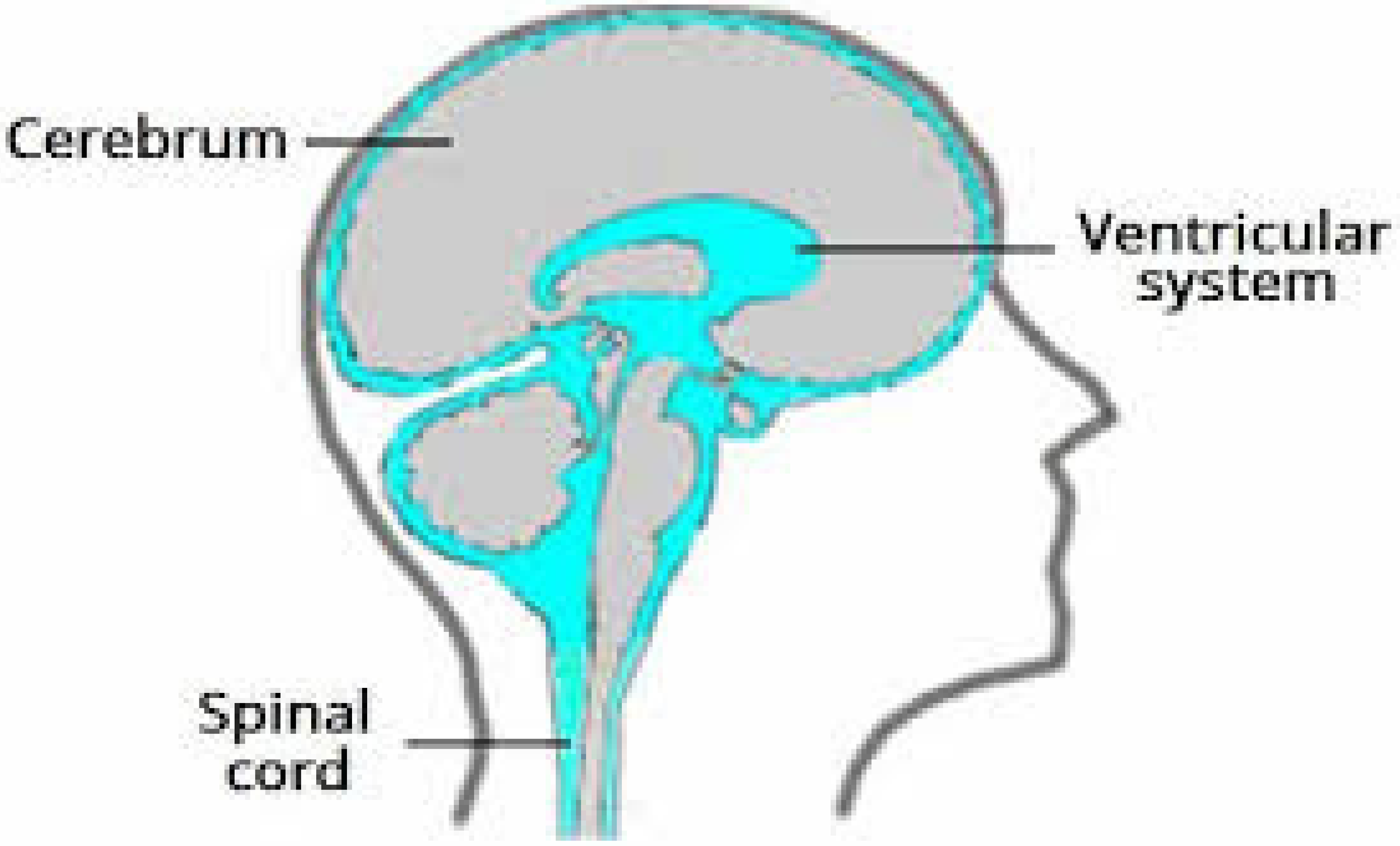
- **Protection:** Cushions brain from mechanical injury.
- **Buoyancy:** Reduces the brain's effective weight by allowing it to float in the cranial cavity.
- **Chemical Stability:** Clears waste products and maintains homeostasis.
- **Nutrition:** Delivers nutrients to CNS tissues.


Dural Sinus
Arachnoid Granulation
Dura Mater
Sub-dural space
Arachnoid mater
Sub-arachnoid space
Pia Mater

THE VENTRICULAR SYSTEM OF THE BRAIN

- The ventricular system is a set of communicating cavities within the brain. These structures are responsible for the production, transport and removal of cerebrospinal fluid, which bathes the central nervous system.
- **Ventricles:** Four interconnected cavities filled with CSF.
- **Lateral Ventricles:** One in each cerebral hemisphere.
- **Third Ventricle:** Between the thalami.
- **Fourth Ventricle:** Between the pons and medulla, continuous with the central canal of the spinal cord.
- **Interventricular foramen (of Monro):** Connects lateral to the third ventricle.
- **Cerebral Aqueduct (of Sylvius):** Connects third and fourth ventricles.


Lateral ventricles
Interventricular foramen
Third ventricle
Cerebral aqueduct
Fourth ventricle
Central canal
(lateral view)
(anterior view)


Cerebrum
Ventricular system
Spinal cord

PARTS OF THE BRAIN

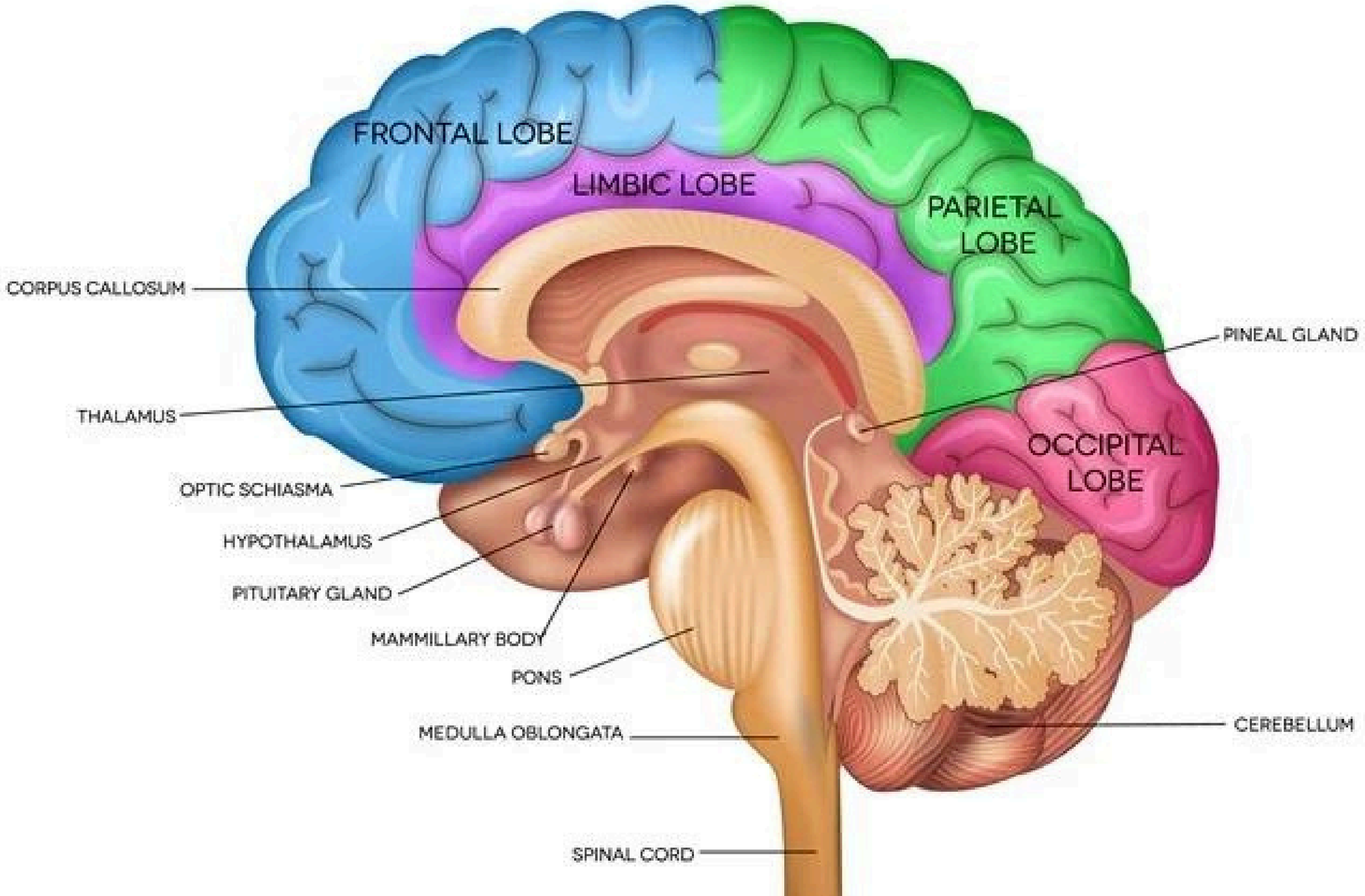
1. **Forebrain (PROSENCEPHALON)**
- *Telencephalon*> CEREBRAL HEMISPHERE > BASAL GANGLIA > HIPPOCAMPUS >AMYDALOID NUCLEUS
- *Diencephalon*

2. **Midbrain (MESENCEPHALON)**
3. **Hindbrain (RHOMBENCEPHALON)**

BRAIN STEM

- *PONS*
- *CEREBELUM (NOT INCLUDED IN BRAIN STEM)*
- *MEDULLA OBLONGATA*

ANATOMY OF THE BRAIN



What Are Gray Matter and White Matter

of the brain?

White Matter

Mostly heavily myelinated axons

Connects brain regions to help with learning, attention, and motor control

Peaks in middle age

Gray Matter

Mostly neuronal cell bodies

Processes and transmits information; controls movement, memory, and emotion

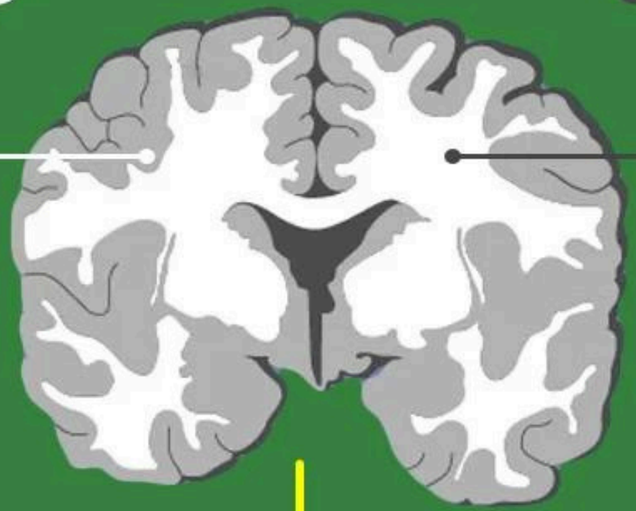
Fully develops in your 20s

healthline


White Matter
Gray Matter

GRAY MATTER

WHITE MATTER



40%
OF THE BRAIN

60%
OF THE BRAIN

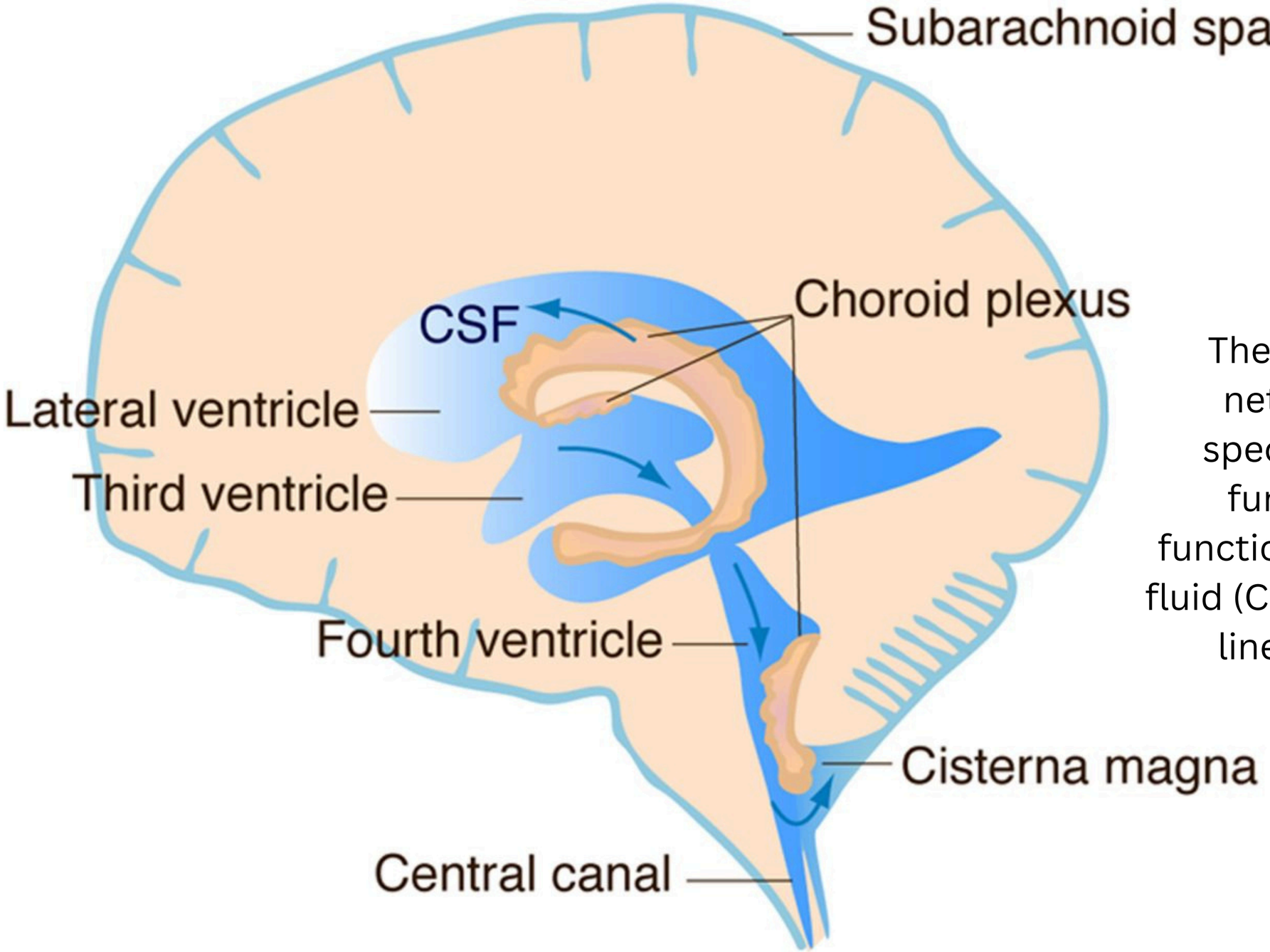
- CONTAINS MOST OF THE BRAINS NEURONAL CELL BODIES
- FULLY DEVELOPS ONCE A PERSON REACHES HIS/HER 20'S
- CONDUCTS, PROCESSES, AND SENDS INFORMATION TO VARIOUS PARTS OF THE BODY.

- MADE UP OF BUNDLES WHICH CONNECT VARIOUSGRAY MATTER AREAS
- DEVELOPS THROUGHOUT THE 20'S AND PEAKS IN MIDDLE AGE
- INTERPRETS SENSORY INFORMATION FROM VARIOUS PARTS OF THE BODY.

DETAILED CIRCULATION OF CSF

- **Step-by-Step CSF Flow:**

1. Produced by the choroid plexus in lateral ventricles.
2. Passes through the interventricular foramina.
3. Enters the third ventricle, flows through the cerebral aqueduct.
4. Enters the fourth ventricle.
5. From the fourth ventricle, CSF exits through lateral and median apertures.
6. Circulates in the subarachnoid space around the brain and spinal cord.

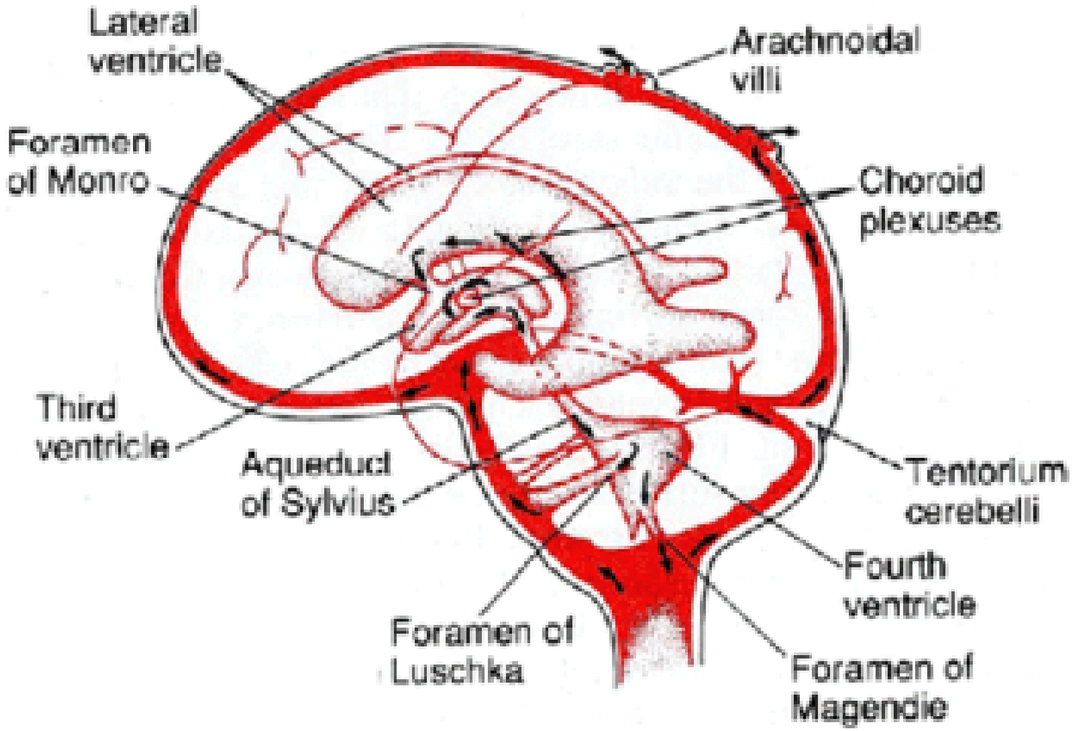


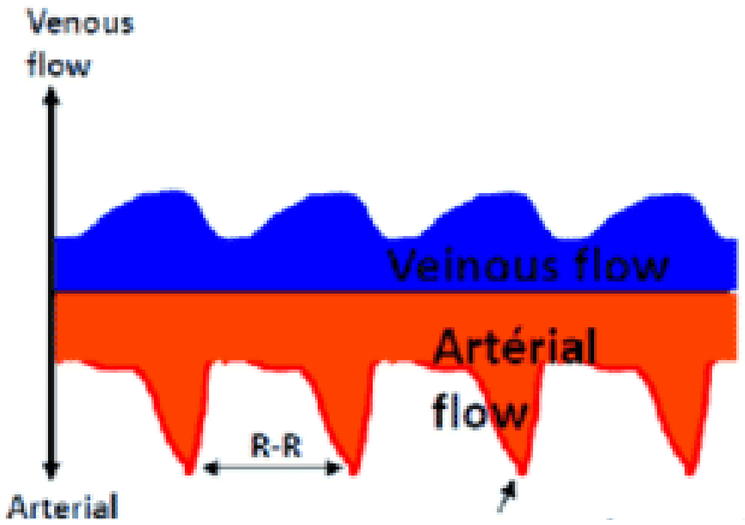
The choroid plexus is a complex network of capillaries lined by specialized cells and has various functions. One of the primary functions is to produce cerebrospinal fluid (CSF) via the ependymal cells that line the ventricles of the brain.

CSF PRODUCTION AND FLOW

- **Choroid Plexus:** Specialized tissue in ventricles producing CSF.
- **Flow Pathway:**
- *Lateral ventricles → Third ventricle → Cerebral aqueduct → Fourth ventricle.*

- CSF exits through lateral and median apertures to subarachnoid space.
- **Absorption:** CSF is absorbed by arachnoid granulations into the superior sagittal sinus.





CSF oscillations

Lateral ventricles

IIIrd ventricle

Cerebral Aqueduct

IVth ventricle

Cisterna Magna

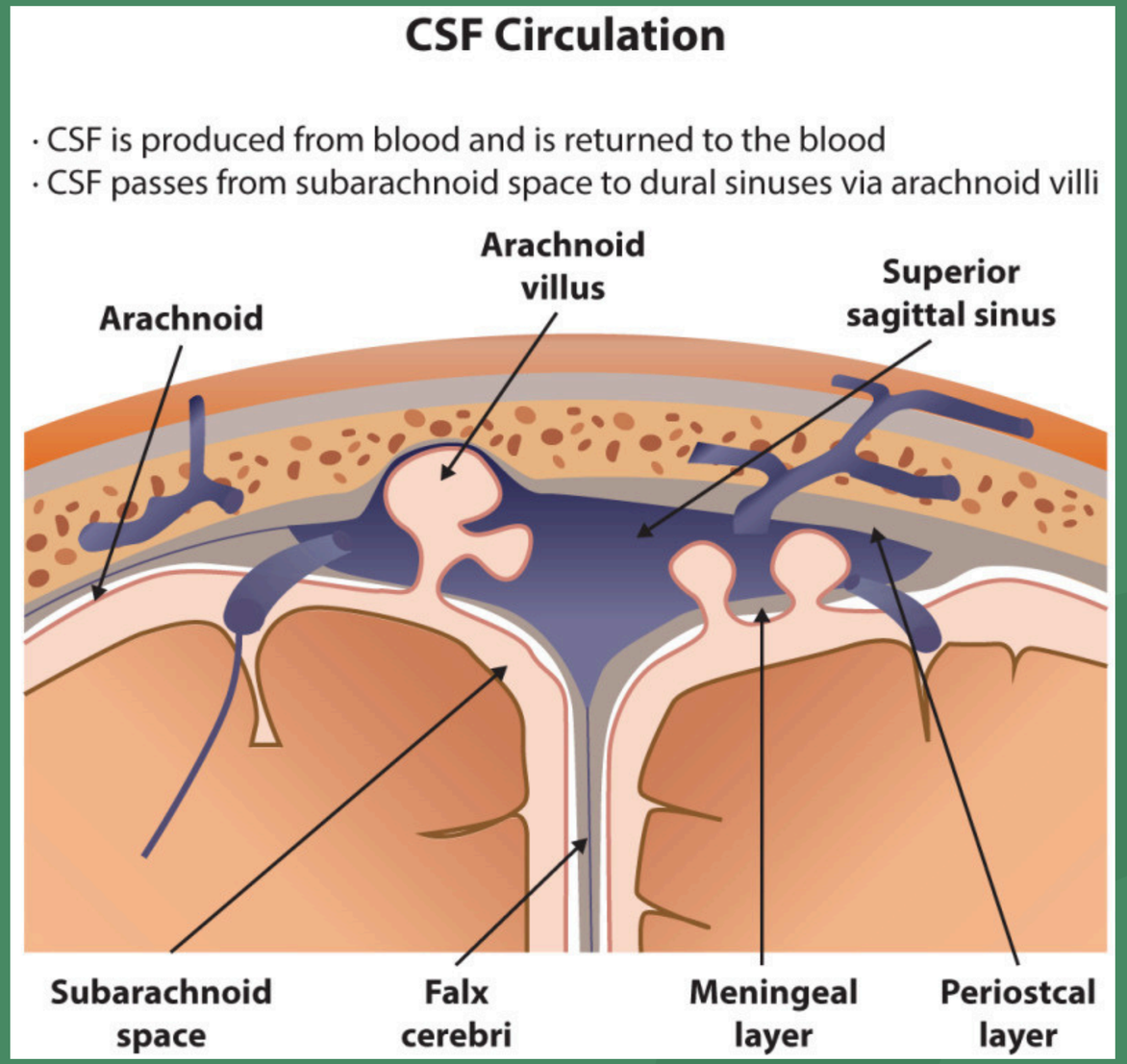
Lumbar CSF space

Subarachnoid space

Sagittal sinus

ROLE OF ARACHNOID VILLI IN CSF ABSORPTION

- **Arachnoid Granulations:** Outpouchings of arachnoid mater into the dural venous sinuses, primarily the superior sagittal sinus.
- **Absorption Mechanism:** Pressure gradient drives CSF into venous circulation.

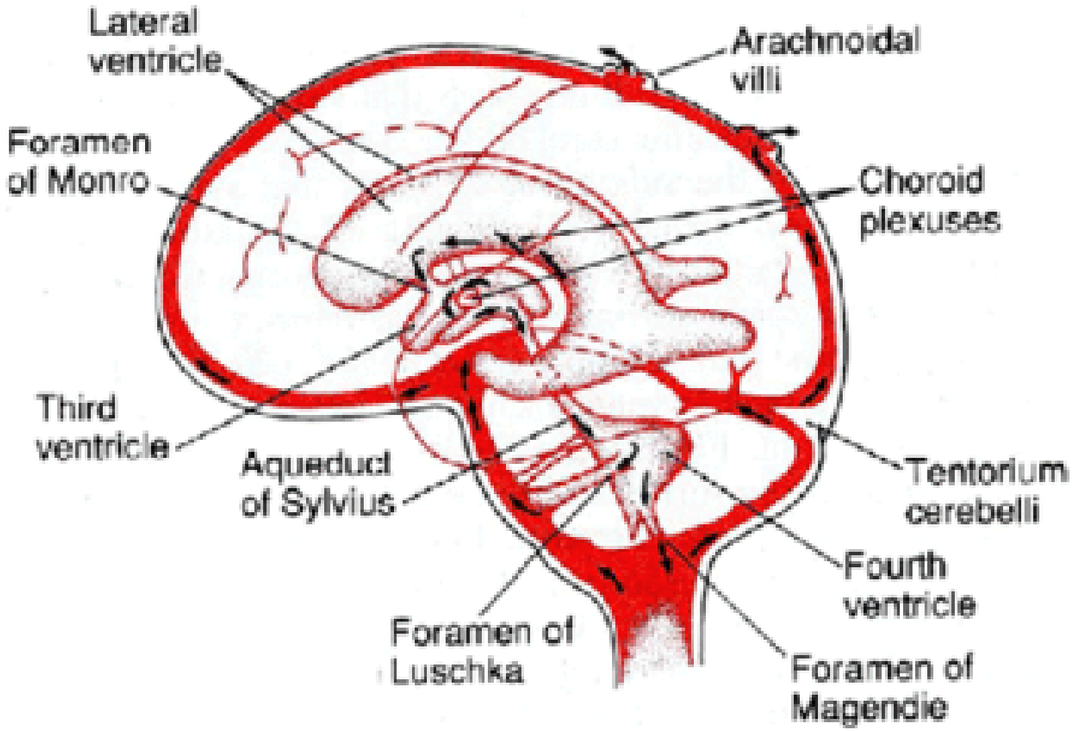


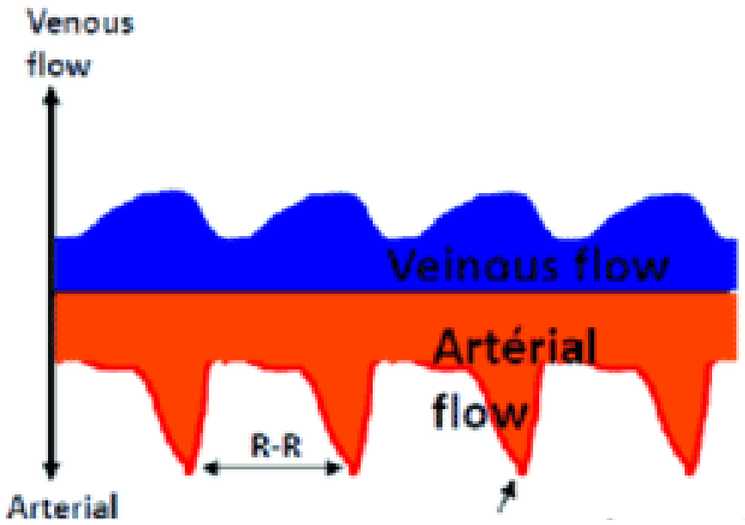
FUNCTIONS OF CEREBROSPINAL FLUID

- **Protection:** Cushions brain from mechanical injury.
- **Buoyancy:** Reduces the brain's effective weight by allowing it to float in the cranial cavity.
- **Chemical Stability:** Clears waste products and maintains homeostasis.
- **Nutrition:** Delivers nutrients to CNS tissues.

CLINICAL CORRELATIONS

- **Hydrocephalus:** Excess CSF in the ventricles causing increased intracranial pressure.
- **Meningitis:** Inflammation of the meninges, potentially affecting CSF circulation.
- **Subarachnoid Hemorrhage:** Blood in the subarachnoid space, disrupting CSF flow





CSF oscillations

Lateral ventricles

IIIrd ventricle

Cerebral Aqueduct

IVth ventricle

Cisterna Magna

Lumbar CSF space

Subarachnoid space

Sagittal sinus